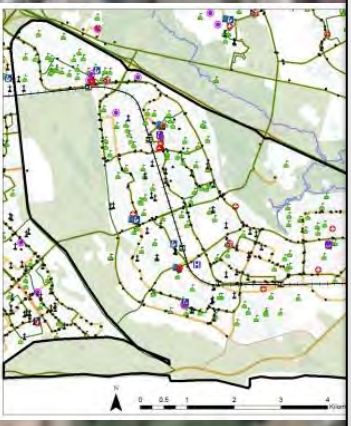

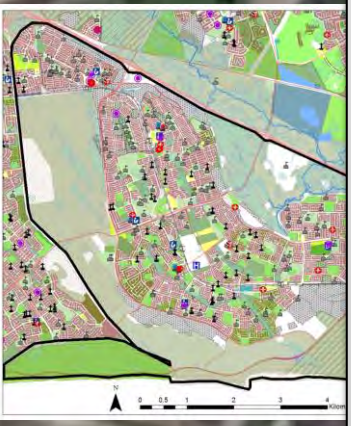

Spatial Planning for Climate Change Adaptation: Developing a Climate Change Local Area Adaptation Plan for Khayelitsha.

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October 2014

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Master of City and Regional Planning

In the School of Architecture, Planning and Geomatics

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ABSTRACT

Climate change is now widely seen as a major challenge of this time and the future of cities. However, the most vulnerable will be the urban poor particularly those located on the urban fringes in high risk areas with limited access to basic services and economic opportunities. In South Africa, although progress has been made to reduce socio-economic and environmental challenges created by apartheid legislations, inequalities still exist where the privileged live in safer and well located and serviced parts of the city while he poor are still located in settlements created by apartheid in urban fringes.

Spatial Planning presents an opportunity to increase resilience to climate change in vulnerable areas of cities. Through integrating planning and climate adaptation actions, future spatial decisions will add to resilience to climate change and enhance wellbeing of people. The dissertation includes a case study that was conducted to learn about the status quo of the study area to effectively recommend relevant interventions that seek to create resilience to climate change in the area. A local area adaptation plan was then formulated including the framework for implementing proposed interventions in a 20 year timeframe.

TABLE OF CONTENTS

Page

LIST OF TABLES, GRAPHS, MAPS AND FIGURES

Tables

Graphs

Maps

Figures

LIST OF ABBREVIATIONS

KPIs – Key Performance Indicators
CoCT – City of Cape Town
UNDP – United Nations Development Programme
CBAs – Critical Biodiversity Areas
CTZS – Cape Town Zoning Scheme
LUMS – Land Use Management System
RSA – Republic of South Africa
WWTP – Waste Water Treatment Plant

CHAPTER 1 INTRODUCTION

1.1 Background

Climate change is now widely seen as a major challenge of this time and the future of cities. As cities grow, their demand for resources also increase, with future shortages of resources expected in cities around the world. These projected shortages are coupled with increasing global populations largely in cities (through urbanization) which increases the demand for and consumption of resources. Disasters resulting from the changing climate present a threat for cities. In addition, socio-economic inequalities in cities render poorer social groups in cities more vulnerable to climate change. As a result, there is a growing realization that the global climate conditions are changing and therefore, there is need for measures and interventions that will reduce the impacts of climate change, especially in the most vulnerable regions. The current rate of growth and consumption resulting to increased emissions and resource exploitation will render the planet earth inhabitable in the future. To this end, there has been a realization of a need to change current global trends in order to secure the future of the planet.

There is now conclusive scientific evidence that global climate trends are changing. Although reducing global greenhouse gas emissions would contribute to reducing global climate change, there is high degree of certainty that future climate conditions will change resulting to threats to cities around the world. Poor urban populations will be most affected by future climate changes and related events aggravated by socio-economic challenges that will increase susceptibility to climate change. This has led to the realization that cities need to change their day-to-day activities, in an attempt to reduce factors contributing to climate change and adapt to projected future impacts of climate change.

The risk from projected climate change is eminent, making resource and infrastructure management more challenging and increasing the need to adapt city activities to future climate change (Mukheibir and Ziervogel, 2007). Furthermore, climate change brings about challenges resulting from an increased likelihood of extreme weather events such as floods, heat waves and droughts and other gradual changes in temperature and rainfall (Mukheibir and Ziervogel, 2007). Temperature changes are likely to increase the demand for electricity for cooling in warm summers and for heating in cold winters. Rainfall changes will also affect Cape Town resulting to chances of floods in wet winters in low-lying areas of the City, and droughts in dry summers.

Consequently, it is the poor and those living in urban fringes that are most vulnerable to climate changes because poor areas generally have inadequate physical infrastructure compared to wealthier urban areas. This raises concerns about social justice and arguments about the need to create inclusive cities, with climate change seen as a factor hindering human development. “The myriad and uncertain effects of a changing climate pose significant risks for development and achievement of the Millennium Development Goals (MDGs)”, (UNDP-UNEP, 2011, 2). Climate Change is also seen as a multiplier to urban poverty as it constitutes an additional burden to people living in poverty through impacts on livelihoods such as losses in crop yields, destruction of property, food insecurity, and loss of sense of place, and indirectly through increased food prices (IPCC, 2014).

1.2 Setting the Scene

Based on the challenges brought about by climate change, there is need for interventions in cities around the world in an attempt to reduce the impacts of climate change, especially in the most vulnerable regions. This is the case in South Africa where climate change issues have been included into national policies, acknowledging the need for reducing urban activities that contribute to climate change as well as responding to future climate changes (RSA, 2010). As a result, climate change mitigation and adaptation plans have been produced to reduce effects of climate change and create

resilient city regions. Climate adaptation refers to taking action in anticipation of future climate effects.

The City of Cape Town has undertaken extensive work on climate change adaptation. For instance, the Energy and Climate Action Plan was approved in 2010 to make the City of Cape Town's commitments operational and for the basis on which to prioritise, budget and implement the City's Climate Change and energy programme (CoCT, 2011). Coordinated by the City of Cape Town's Energy and Climate Change Unit, the action plan outlined objectives including targets and implementation plans as well as projects to be implemented. However, the action plan focuses on the energy aspect of climate change, with a goal of creating a reduced city carbon footprint, energy efficiency and increased access to cheap and clean energy to Cape Town residents (CoCT, 2011).

Although the City of Cape Town has initiated climate change adaptation plans, most work has been carried out in the environmental institutional sectors with limited integration into development and spatial planning institutions and frameworks (Taylor et.al., 2013). This limits integration of interventions dealing with climate change as climate change is interpreted as a predominant environmental issue; it is mostly handled by environmental bodies. Because in practice climate change continues to be addressed separate from economic growth and the provision of public services, "adaptation efforts tend not to feature as a systemic element of municipal planning and budgeting" (Taylor et.al., 2013, 66).

Furthermore, while there have been attempts to respond to climate change, there has not been enough integration of climate change issues into spatial planning and urban development in Cape Town especially in poor and most vulnerable areas. One of the limiting factors hindering progress with tackling climate change is the extent to which climate change is largely seen as an environmental issue, separate from development (Taylor et.al., 2013). This highlights a need to better integrate climate change adaptation into spatial planning and development. An effective climate change response requires economic, social and environmental interventions that integrate adaptation into a

developmental framework (RSA, 2010). In addition, climate change vulnerabilities in poor areas are going to increase as a result of the slow pace in the delivery of basic services such as adequate housing, health care, and other infrastructure, which will poses more challenges for the city in terms of the services that have to be provided (Mokwena, 2009).

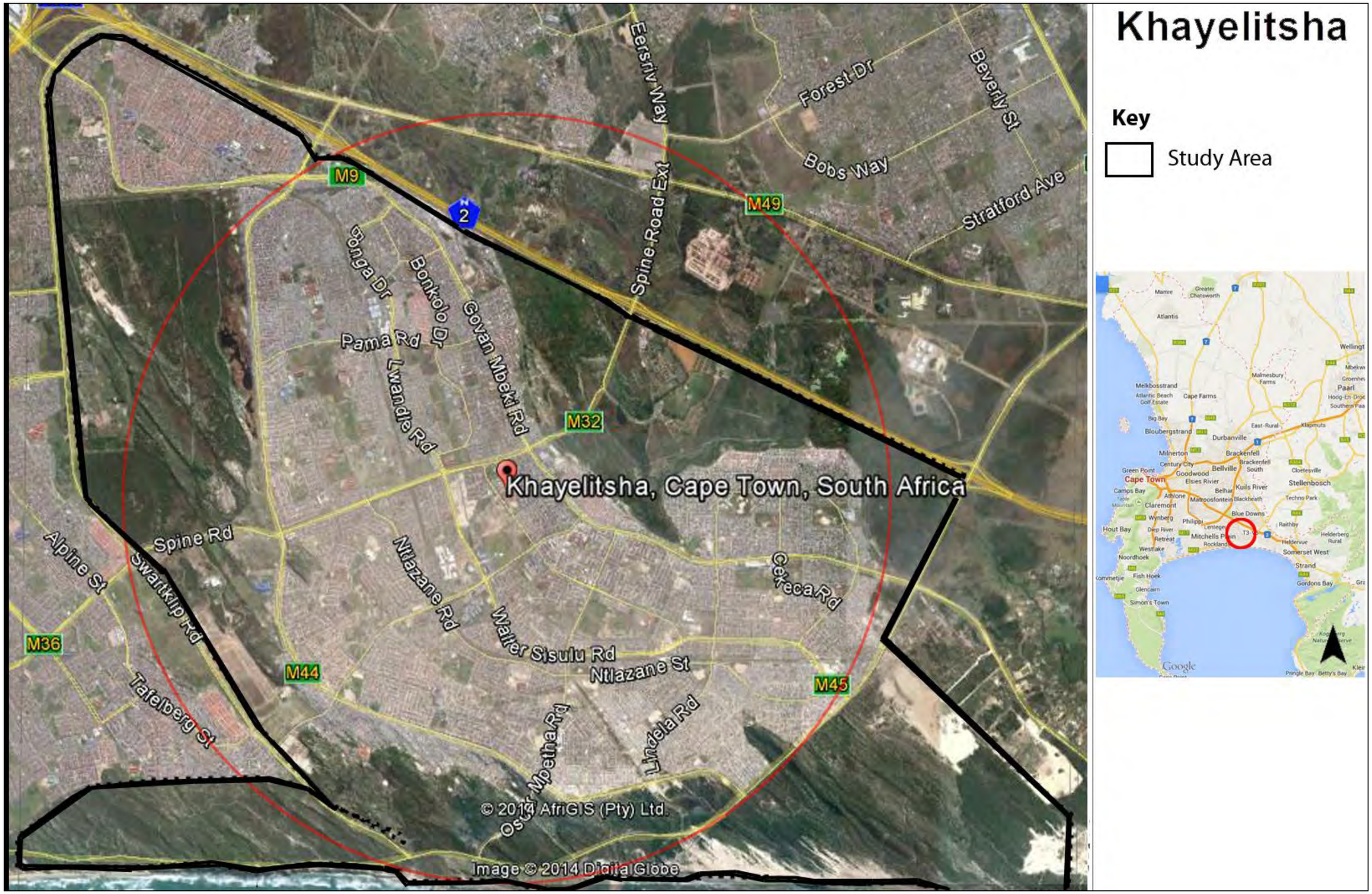
1.3 Philosophical Standpoint

Given predicted climate change effects, people will be affected particularly the poor. However, I believe priority should be given to poor communities to ensure that socio-economic issues are managed and to uplift poor communities into contributors to the economy. If poverty was eradicated and economic opportunities created, people would have the ability to prepare for adaptation to future climate change as well as afford to relocate to safer areas. I believe poverty limits people's options and abilities to work for them and create self-sufficient communities that are not dependent on public support to survive.

In order to adapt to climate change, I believe decision makers should drive the adaptation process from policy state to on the ground initiatives that would yield quantifiable results. Although the success of these adaptation initiatives is not guaranteed, applying initiatives and plans on the ground would create a foundation on which adaptation would be built upon and improved over time.

1.3 Scope and Study Area

The scope of this dissertation involves developing a climate change adaptation plan for Khayelitsha. Because of the fragmented nature of current spatial plans from adaptation strategies, this dissertation identifies an opportunity to integrate adaptation into spatial planning in Khayelitsha. The Khayelitsha area (see Map 1.1) forms part of the Khayelitsha/Michells Plain district (Planning District F) located in the metropolitan South East area of Cape Town also known as the Cape Flats area. Map 1.1 (right) shows the location of Khayelitsha within the City of Cape Town municipal area, and the study area boundary (left map).



Map 1.1: Khayelitsha Location in Cape Town and a Boundary of the Study Area. (By Author. Source: Google Maps, 2014).

1.4 Problem Statement

Although the Energy and Climate Action Plan includes plans to increase resilience in the City's vulnerable communities, the focus is on energy access and efficiency as it is the case at the city level. In addition, these climate change adaptation efforts are separate from spatial plans for the study area. The current district plan for Khayelitsha (the Khayelitsha – Mitchells Plain District Plan) does not explicitly focus on climate change adaptation and does not include climate change plans for the area, which suggests a gap and lack of integration between climate change adaptation and spatial planning in the study area.

The Cape Town Metro South-East is particularly susceptible to climate related challenges because of the area's inadequate physical and social infrastructure, which is the case in Khayelitsha. According to Baphumelele (2014, 1) Khayelitsha is one of the most marginalised and poverty-stricken townships in South Africa". This means that poor areas are likely to be the most affected by climate change in the Cape Town metropolitan area. The poor and marginalized usually have the least buffer to face even small climate hazards, and suffer most from continual events with limited recovery time (IPCC, 2014). This is the case for Khayelitsha where floods in winter and heat waves in summer occur annually. According to the IPCC (2014, 8), "Poverty and persistent inequality are the most salient of the conditions that shape climate related vulnerability". This necessitates a need for integrating different climate adaptation measures that have been adopted by the City of Cape Town into spatial planning to develop local area interventions, and make poor areas resilient to shifting local and global climate.

This study will attempt to develop a local area climate change adaptation plan that would attempt to integrate climate change adaptation into spatial planning, aimed at reducing climate change vulnerabilities of residents of Khayelitsha. Due to a local scale of focus for this dissertation, Khayelitsha was chosen. This choice is also based on the author's relationship with the place and a personal connection with the place.

1.5 Justification for this Study

For the City of Cape Town to be inclusive and socially just, all issues affecting quality of life of all people should be addressed. After 20 years of independence in South Africa, Cape Town is still spatially divided. This hinders transformation and democracy with regards to moving from the previous apartheid city towards a more inclusive city. These spatial divisions are also linked to income divisions and spatial segregation, where the poor are located in the fringes of the city with limited access to good quality services and infrastructures.

As a result of poor physical infrastructure quality in these urban fringes, people living in these areas are more vulnerable to climate change issues such as floods, heat waves, droughts and are even more threatened by future changes in climate. These challenges pose a threat to human development and the quality of life for the majority of residents in poor areas of the city such as Khayelitsha. There are also inequalities threatening socio-environmental justice, where people in developed areas of the city have access to adequate social facilities and increased environmental wellbeing than people in poor urban fringes where environmental resources are usually depleted or are in poor quality.

Therefore, there should be precautionary measures to natural disasters and climate change than responsive strategies that seek to support people affected by subsequent disasters. Planning has the potential to play an important role in creating policies and plans that account for the provision of sound infrastructure for the poor to reduce vulnerability and recurring effects of climate change. Planning could also create green public spaces and improve the quality of the natural resources in the study area, thereby promoting environmental quality as well as environmental justice.

1.6 Purpose of this Research

The study aims to address climate change related challenges in the City of Cape Town municipal area through an adaptation plan that aims to reduce the vulnerabilities to climate change in Khayelitsha. This is based on the justifications above on the threats of

climate change on poor communities. Because poorer settlements are usually more vulnerable to climate change than more developed areas (Kelly and Adger, 2000), this study will put forward interventions that will address development issues that increase susceptibility to climate change while simultaneously increasing adaptation to future climate change. It is hoped that the proposed interventions would result to a plan that has both adaptation and spatial planning aspects, thus increase people's standards of living while reducing vulnerability to climate change.

1.7 Research Questions

The study seeks to answer the following question:

What is the role of spatial planning in climate change adaptation in Cape Town? In other words, how can spatial planning for climate change adaptation to achieve better settlement and natural resource resilience and promote people's wellbeing in Cape Town?

Subsidiary research questions include:

What is the current state of practice for climate change adaptation in Cape Town?

What are the anticipated climate change trends for Cape Town, and what are the resulting vulnerabilities in the context of Khayelitsha?

How can current City of Cape Town climate change initiatives be better integrated into local area spatial planning interventions?

What are Cape Town municipality's opportunities and limitations faced with regards to climate change adaptation?

These research questions will be used to guide the context analysis in chapter 3 to ensure that the analysis reveals the main trends this dissertation seeks to find. The questions will provide insight into the current plans and where they are implemented within the Cape Town Metropolitan area. This will be used to inform the local area adaptation plan for Khayelitsha.

1.8 Research Methods

1.8.1 Introduction

The purpose of this section is to set out the methodology that will be followed to effectively answer the research questions in this report. This section will seek to motivate the choice to adopt a case study method. The research methods section shows the procedures taken from the problem identification through to the local area plan. This section includes tools used to inform the climate change adaptation plan for Khayelitsha and shows how each step would be carried out.

1.8.2 Case Study

A case study research method is conducted to acquire in-depth information about the study area. A case study method was chosen because it would help define the study area, and add important insight that will guide the development of an adaptation plan for the study area. According to Flyvbjerg (2011), the case study method allows for a production of context dependent knowledge that lies at the core of expert activity. Therefore, completion of a contextual analysis would reveal a background understanding (social, environmental and economic context) of the study area of Khayelitsha, which informs the development of the local area climate change adaptation plan for Khayelitsha.

1.8.3 Policy Analysis

A review of policies that are applicable to climate change adaptation is conducted, looking for opportunities and limitations in current policies at the national, provincial and local levels. This reveals the links (if any) between spatial planning and climate change adaptation plans in current policies. In addition, a study of current development frameworks for Khayelitsha, such as the Khayelitsha/Mitchells Plain District Plan as well as the Cape Town Spatial Development Framework will be completed to reveal any climate change initiatives in the existing planning tools for Khayelitsha.

1.8.4 Discourse Analysis

To understand the role of planning a discourse analysis of existing written and discourse material is conducted. This analysis sheds light to the role of planning in climate change adaptation. The analysis entails working across the two disciplines of climate change and spatial planning to reveal the current relationship between the two disciplines and their fields of practices. The need to undertake a discourse analysis is to substantiate or disprove a relationship between spatial planning and climate change through an analysis of written or spoken dialogues.

1.8.5 Geographical Information Systems Analysis (GIS)

GIS was used to analysis spatial information detailing the current state of Khayelitsha which was then represented in maps in this dissertation. The advantage of using GIS is that it yields spatial results than can reveal trends and areas that are of high risk requiring urgent interventions.

1.8.6 Overview of the Approach

A desktop study is conducted to analyse the current state of Cape Town's climate, and how it is predicted to change. This analysis helps broaden an understanding of climate change and support arguments for the need for an adaptation plan in Cape Town to endure the challenges resulting from changes in climate. Conducting a desktop study explores the broad climate change adaptation literature (on an international level, in South Africa then zooming into the local level).

The local area desktop study assists with gathering information on the state of Cape Town's climate change and adaptation interventions that have been proposed to reduce vulnerabilities to climate change. In addition, a review of literature on climate change adaptation and the role of planning in climate change adaptation in the global context and then in the South African context is conducted. This also involves a review of spatial planning literature in search of possible links between planning and climate change adaptation.

Thereafter, one-on-one interviews with spatial planners as well as a review of current climate change interventions are conducted. To this end, the interviews conducted seek to ascertain the link between climate change adaptation and spatial planning practice in current interventions from a professional point of view, including a focus on the study area of Khayelitsha. This would reveal the role of planning as well as the current state of climate change adaptation in the study area, looking at the current climate change adaptation strategies. These interviews seek to add to the findings and understanding gathered from the theoretical review and local area context study. A brief review of current climate change adaptation plans for the City of Cape Town is conducted, with argument that these adaptation plans need to be integrated and harmonised with spatial and development plans. This would be demonstrated through a local plan for Khayelitsha as a product of this dissertation.

Upon completion of the contextual exploration of the study area which should reveal the status quo of the relationship between planning and climate change in Khayelitsha; this information is then used to plan for a climate change adaptation intervention as a product of this study. This study produces a local area climate change adaptation plan for Khayelitsha.

1.8.7 Investigating Climate Change and Climate Change Adaptation

In conducting this research, a review of climate change adaptation and climate change vulnerability literature is conducted. This helps build knowledge and an understanding from assessing current theories related to climate change adaptation and spatial planning in vulnerable areas. In addition, a study area specific study is conducted to highlight the local area specific conditions which inform the local area adaptation plan. Furthermore, a literature review is conducted to outline the current debate and theories that are applied to the study area, thus reveal any contradictions in the study field.

1.9 Limitations of This Dissertation

1.9.1 Researcher Bias

However, there is a danger of the researcher's own subjective thoughts influencing the results of the case study research which would result to a degree of bias and reduced validation. As such, the use of other research methods such as discourse analysis and a review of literature and documents would mitigate the researcher's biases.

1.9.2 Timeline

The available time for completing this dissertation does not allow for a full scientific research process to occur. As a result, the research methodology does not include all the steps required to ensure that a scientific process is followed and findings are tested for accuracy and reliability. However, the study uses a mixture of research methods to ensure that the plan is well informed as well as a use of sources recognized academically reliable such as published theories, climate change scientific studies, government and non-governmental organization publications.

1.10 Type and Potential Uses of the Proposed Adaptation Plan

At the completion of this dissertation, it is hoped that this dissertation would demonstrate the integration of climate change adaptation into spatial planning practice at the local level of governance, through a local area adaptation plan for Khayelitsha. By integrating climate change adaptation better into spatial planning at a local level, it is hoped that some ideas from this study could be of value for creating climate change adaptation plans in other areas with characteristics similar to Khayelitsha. In addition, work in this dissertation could potentially add to policy debate that could result to increased insight on how to adapt to climate change at a local area scale, and lead to the creation of an integrated climate change adaptation plans that would inform decision makers in their attempts to create sustainable urban communities.

1.11 Structure of the Dissertation

This dissertation is divided into several chapters advancing from theoretical review, to study area context analysis, through to the application of findings about the study area

through the formation of an adaptation plan for the study area and implementation of the plan.

Chapter 2 This chapter seeks to outline and explore some contemporary theoretical texts that will investigate the relationship between spatial planning and climate change adaptation. More specifically, the main philosophical standpoint was being discussed, pointing to some major debates that are relevant to the completion of this study. This chapter will also evaluate some concepts and methods that have been adopted in an attempt to promote climate resilience. In additions, challenges brought about by climate change are highlighted in this chapter, forming the base for the argument of a need for interventions in cities to reduce the challenges resulting from climate change. This is important as it informs the local area adaptation plan that is the main aim and product of this dissertation.

Chapter 3 Presents a contextual analysis of the study area exploring the status quo of the study area in relation to its socio-economic and environmental vulnerabilities to climate change. This would ensure that trends are identified in the area that will guide the creation of interventions in the area to addresses the local area specific issues related to the changing climate conditions.

Chapter 4 Presents the local area adaptation plan for Khayelitsha.

Chapter 5 Details the implementation of the local area adaptation plan, highlighting potential stakeholders and a timeline for the adaptation plans to be implemented gradually over time.

Chapter 6 presents the conclusions and discussions for the dissertations, summing up the main points and findings about adaptation planning for the study area. This chapter will also point out some limitations of this study and highlight gaps for future research.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This chapter seeks to explore some contemporary theoretical texts that evaluate the relationship between climate change adaptation and spatial planning at a city scale. This literature review provides main concepts and themes explored in this dissertation. The chapter begins with a definition of climate change and its resulting impacts. Thereafter, the main argument about the effects of climate change in cities is outlined, highlighting cities in developing countries as relatively more vulnerable to climate change. Climate change adaptation and resilience themes are discussed. Thereafter, the role of planning in climate change adaptation is discussed. The literature review concludes with a summary of major constraints and limitations to climate change adaptation in literature.

2.2 Defining Climate Change

The UN-Habitat (2011: 5) defines climate change as "a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer". Global climate conditions are changing with new peaks reached in recent years. According to the UN Inter-Governmental Panel on Climate Change (IPCC) findings, highest temperatures have been recorded in the decade from 1990 onwards resulting to increased frequency of extreme weather events (UNDP, 2007).

According to Younger et.al. (2008) greenhouse gas emissions resulting from human activities is largely the source of the accelerated rate of climate change. "These human-generated gases derive in part from aspects of the built environment such as transportation systems and infrastructure, building construction and operation, and land-use planning" (Younger et.al., 2008 :517). In addition, land use and agriculture also add to climate change through the clearing of vegetation and the gases emitted from these activities (Younger et.al., 2008).

2.3 Impacts of Climate change

Climate change creates challenges for cities. However, the dominant impacts of climate change are those linked to flooding (from sea level rise, rising groundwater levels and rivers), availability of water resource (water quality and quantity), public health from heat extremes and ozone, and energy demand (Hunt and Watkiss, 2007; IPCC, 2007). Emphasis on these impacts "reflects areas where public infrastructure is currently under most pressure from socio-economic development, as well as where a city's resource needs are most climate-sensitive" (Hunt and Watkiss, 2007: 41). The increase in the rate of climate change will further increase the severity of these challenges on cities. According to Matthews (2011: 3) specific climate change effects on urban areas will differ depending on location, "but may include reductions in potable water, more regular and severe weather events such as heavy rain-falls and cyclones, increased incidences of flooding, inland storm surges and an increase in extreme heat events".

A brief summary of impact by category is included below highlighting impacts of climate change on cities. This helps demonstrate significant areas likely to be affected by climate change and resulting to severe challenges posed to cities.

2.3.1 Coastal areas

Climate change affects coastal areas as it results to the increased rate of events resulting from sea level rise such as near-shore waves and currents (Hunt and Watkiss, 2007). These could result to tidal waves which increase the probability of coastal flooding and erosion. In addition, sea-level rise and human development together add to losses of coastal wetlands and result to increased damage from coastal flooding (IPCC, 2007). According to Hunt and Watkiss (2007) adaptation strategies to sea level rise include:

> Coastal defences (e.g. physical barriers to flooding and coastal erosion such as dikes and flood barriers); realignment of coastal defences landwards; abandonment (managed or unmanaged); measures to reduce the energy of near-shore waves and currents; coastal morphological management; and resilience-building strategies
>
> (Hunt and Watkiss, 2007: 20).

2.3.2 The built environment

Extreme climate change events have been identified as the major impacts affecting the built environment, identified in form of storms and floods, heatwaves and drought (Hunt and Watkiss, 2007). Severities of these effects are likely to be intensified the physical size of the city and therefore, will be different according to location around the world (IPCC, 2007). This will also include developed nations where storms are already the costliest weather events (Hunt and Watkiss, 2007).

2.3.3 Energy

Energy demand is linked to climatic conditions, with climate change likely to result to fluctuations in demand for energy for heating and cooling in winter and summer seasons respectively. Hunt and Watkiss (2007: 23) argue that "as a general statement, there is likely to be a decrease in the demand for winter heating, but an increase is summer cooling (which can be described as either an impact or an adaptation), though the scale of these effects is strongly determined by the climatic zone and also socio-economic conditions" (Hunt and Watkiss, 2007: 23). In cities, these energy demands are important because of the concentration of industries in cities (and the resulting demand for energy), and because of increasing energy demand for cooling as a result of increased temperatures for example, in cases of heat islands (Hunt and Watkiss, 2007).

2.3.4 Health

Climate change is likely to affect human health either directly from heat and cold effects, or indirectly, for example, through increased transmission pathogens, or through effects on well-being from extreme weather events (Hunt and Watkiss, 2007; Scheraga and Grambsch, 1998). Therefore, recognition of these additional health effects will be more important in cities with large population sizes and in developing countries with greater vulnerabilities, for instance, as a result of low standards of health care provision (Hunt and Watkiss, 2007).

2.3.5 Water

Climate change will potentially affect overall global demand for water as well as water availability. Increases in average atmospheric temperature will increase water loss through evaporation and demand for cooling human settlements, thereby increasing overall water demand, at the same time either increasing or decreasing water supplies (Hunt and Watkiss, 2007; Matthews, 2011). According to the IPCC (2007: 36) "current water management practices are very likely to be inadequate to reduce the negative impacts of climate change on water-supply reliability, flood risk, health, energy and aquatic ecosystems". In addition, climate change affects water infrastructure as well as water management practices, thus global water demand will increase in the next decades as a result of population growth and loss of water quality resulting from effects of climate change (IPCC, 2007).

2.3.6 Urban biodiversity

Climate change will potentially affect urban and surrounding biodiversity and ecosystems (IPCC, 2007), which could affect recreational as well as aspects such as resource availability and protection (Hunt and Watkiss, 2007). However, climate change impacts on urban ecosystems or biodiversity have received relatively little attention in comparison to major threats on ecosystems (Hunt and Watkiss, 2007). In addition to biodiversity, future changes in the frequency and severity of extreme climate events will affect other areas such as agriculture produce and forests increasing the threat from food insecurity (IPCC, 2007).

2.4 Climate Change in the Urban Context

Climate change is now widely recognised as a major challenge facing cities in the 21st century (Friesecke et.al., 2012), and is "receiving greater attention from the international development community" (UNFPA, 2008: 1). The intensity of the effects of climate change in cities is increasing, making resource and infrastructure management more challenging and increasing the need to adapt activities of cities to future changes in climate (Mukheibir and Ziervogel, 2007). According to Gill (2004: 10) "extreme events

are especially significant in the urban environment where concentrated human populations and high property values mean that the potential for loss is very significant". Climate change will present global states with growing events affecting cities and livelihoods. "Climate change is likely to bring changes in climate variability and extreme events, such as more frequent heatwaves, less frequent cold spells, and a greater intensity of heavy rainfall events", (IPCC, 2001 cited in Gill, 2004: 9).

Romero-Lanko (2008) also states that urban areas will be faced with increases in the frequency and intensity of heavy rains, storms, droughts, heat-waves and other extreme weather events, with areas that are already experiencing widespread changes in climate becoming more at risk. Climate change impacts will result to natural resource depletion (resulting to the destruction of natural habitats and ecosystems) in cities as well as environmental quality decline which would result to poor environmental health (UNFPA, 2008), social and economic challenges for urban settlements.

According to (UNFPA, 2008) most environmental problems including the challenges from climate change are usually a result of population growth and a large population size, thus the fact that the global population size has reached 6.7 billion and is growing at a fast annual growth rate should be considered relevant. Urban populations are increasing rapidly and will continue increasing in the next decades especially in developing nations (Friesecke et.al., 2012). According to the United Nations (2009), the world's urban population is expected to increase by 84% by 2050, with the expected urban growth concentrated in urban areas of less developed regions (Taylor and Peter, 2014; Friesecke et.al., 2012). In addition, "rapid urbanisation is largely taking place within the slums and informal settlements of developing-world cities in Africa and Asia, where multiple pressures combine with climate change impacts to exacerbate pre-existing vulnerabilities and inequalities" (Taylor and Peter, 2014: 2). With the majority of the world population now living in urban areas, with larger populations in cities of developing countries (Wilby, 2007), the majority of people residing in these cities will be increasingly affected by climate change.

The relationship between rapid urbanisation and climate change presents potential threats because “urban areas, with their high concentration of people, industries and infrastructure, are likely to face the most severe impacts of climate change” (Friesecke et.al., 2012: 4). Furthermore, the majority of people affected by climate change will be the urban poor (Hoornweg et.al., 2010; UNDP, 2007; Schipper et.al., 2010). “Unless action is taken to greatly reduce emissions, and enact adaptation measures, many of these hard won development gains could start to be reversed in the decades to come” (Khoday, 2007: 3). As a result of urban population growth, demand for resources to support the increased urban population and resulting urban activities (UNFPA, 2008), and land needed for commercial and settlement expansion will also increase. This will result to cities increasingly contributing to environmental degradation and immense ecological burdens (Hoornweg et.al., 2010). According to the UNFPA (2008: 4) with the current state of cities, a “sudden supply shortages, heavy environmental burdens or major catastrophes can quickly lead to serious emergencies”.

In addition to environmental degradation, other socio-economic issues such as income and social inequality and poverty will also increase mostly in cities of developing countries (Wilby, 2007). This would undermine human development and poverty alleviation efforts (UNDP, 2007; IPCC, 2007). “Over the next half-century, climate change could impede achievement of the MDGs”, (IPCC, 2007: 20). As stated by the UNDP-UNEP (2011, 2) “the myriad and uncertain effects of a changing climate pose significant risks for development and achievement of the Millennium Development Goals (MDGs)”. According to the IPCC (2014: 3), climate change impacts include “effects on lives, livelihoods, health status, ecosystems, economic, social, and cultural assets, services (including environmental), and infrastructure, due to the interaction of climate changes or hazardous climate events occurring within a specific time period”. Concequently, development progress achieved will be hindered by changing climate conditions, and thus the fight against poverty and climate change should be address in parallel (UNDP, 2007).

Climate change affects poor countries more than wealthier countries (Kelly and Adger, 2000) because of different levels of development as well as population densities in those nations (Moser and Satterthwaite, 2008). Although climate change adaptation was considered to be a challenge affecting developing nations, it is now included on agendas of the majority (if not all) of developed countries (Peltonen et.al., 2010). Furthermore, with the increasing intensity of weather conditions as a result of climate change, "settlements with relatively good quality housing and protective infrastructure are also at risk", (Moser and Sutterthwaite, 2008: 10).

Friesecke et.al., (2012) also argues that climate change threatens all countries and therefore, international cooperation in dealing with climate change is needed. This means that vulnerabilities to climate change are likely to increase across cities in all nations in the future. Haines et. al., (2006) cited in Wilby (2007: 31) states that "the vulnerable populations of many low-income countries are already exposed to shortages of clean drinking water and poor sanitation, and often occupy high-risk areas such as floodplains and coastal zones". Developing countries are considered to be more vulnerable because most of them are located in tropical and sub-tropical areas where economies and societies are highly dependent upon climate and would be affected by its variations (Kreimer et.al., 2003).

As a result, risks in most cities and towns in least developed nations fall excessively on the populations living on high-risk areas with limited access to good quality infrastructure and services (Moser and Sutterthwaite, 2008). Furthermore, urban poverty is linked to poor social services and inadequate infrastructure as a result, poor urban communities become more vulnerable to the effects of climate change (Moser and Sutterthwaite, 2008). Because these low-income urban areas are occupied by the poor, densely populated and commonly located on the outskirts of cities, they usually have inadequate infrastructures to cope with changing climate conditions and resulting impacts.

In addition, other authors recognise a need to address underlying socio-economic issues that increase vulnerabilities to climate change, especially in least developed nations that are most susceptible to climate change. For instance, UNFPA (2008) argues that rapid population growth in low income countries combines with poverty and resources constraints to intensify environmental degradation and inhibiting sustainable development. Therefore, slowing the population growth rate in developing countries may aid with time and resources to deal with climate change and reduce vulnerability (UNFPA, 2008). According to Malik (2013: 10) "climate change is already exacerbating chronic environmental threats, and ecosystem losses are constraining livelihood opportunities, especially for poor people". Climate change is predominantly seen as a multiplier to urban poverty as it constitutes an additional burden to people living in poverty through impacts on livelihoods such as losses in crop yields, destruction of property, food insecurity, and loss of sense of place, and indirectly through increased food prices (IPCC, 2014).

The growing urban population further adds to increased demand for infrastructure and services, which would render those without access more vulnerable to climate change, and would result to unequal access to quality infrastructure and services. Cochrane and Constolanski (2013: 194) argue that "the concentration of populations in urban areas magnifies vulnerabilities as poverty interacts with diminishing municipal services and climate change, with its attendant environmental disruptions such as declining rainfall, rising temperatures and water and food scarcity". As a result of increasing effects of climate change, there has been a move for enabling vulnerable settlements to adapt to climate change and thus reduce the negative impacts resulting from the changing global climate conditions.

Although cities are mainly viewed as one of the major sources of global warming and climate change, they offer opportunities for enabling resilience to future climate change (Friesecke et.al., 2012; Lamia and Robert, 2009; UN-Habitat, 2011). Because of the excessive extraction of resources and emissions from production activities, energy and

transport coupled with clearing of forests for the built urban environment, cities are usually seen as a problem adding to the changing climate (Lamia and Robert 2009). Hunt (2004) cited in Wilby (2007) highlights the observations made by other scholars pointing to the contribution made by major global cities to climate change. In contrast, cities are seen as an opportunity in an attempt to address global climate change (Friesecke et.al., 2012; UN-Habitat, 2011). Increased intensities of these climate change impacts has resulted to recognition that cities, and urban development presents an opportunity to reduce the effects of climate change and create cities that are more resistant to changing climate conditions. For instance, Friesecke et.al., (2012: 4) argue that "urbanisation will also offer opportunities to develop climate change mitigation and adaptation measures".

2.5 Climate Change Adaptation and Resilience

There is need to create urban areas that are resistant to climate change and have reduced additions to causes of climate change. Khoday (2007: 3) maintains that "with the impacts of climate change felt more frequently in various parts of the world in the form of severe droughts, water shortages and extreme weather events, the time for speculation over the causes and consequences of climate change is over". This highlights a need to create cities that will withstand the unavoidable effects of climate change. There are different strategies identified as effective in dealing with climate change including climate change mitigation and adaptation as the major strategies. Scheraga and Grambsch (1998: 85) argue that to reduce the risks and take advantage of the opportunities that climate change brings, "a portfolio consisting of strategies both to mitigate emissions of greenhouse gases and to adapt to change should be considered". The IPCC recognizes:

> The value of a portfolio or mix of strategies that includes mitigation, adaptation, technological development (to enhance both adaptation and mitigation) and research (on climate science, impacts, adaptation and mitigation). Such portfolios could combine policies with incentive-based approaches, and actions at all levels from the individual citizen through to national governments and international organisations

(IPCC, 2007: 20).

Climate change mitigation refers to efforts to reduce activities that add to the emission of greenhouse gases to reduce the rate of global warming and climate change (UNEP, 2014; IPCC, 2007). The IPCC (2007: 750) defines climate change mitigation as "an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases". Mitigation can mean inventing new technologies and reducing reliance on non-renewable energies and altering older equipment to efficiently require less energy, or changing management practices or consumer behaviour (UNEP, 2014). In addition, climate change mitigation could involve protecting natural resources like forests and oceans, or creating new green spaces. In urban contexts, mitigation could also refer to redesigning infrastructure and reducing consumption in urban areas (UNEP, 2014). Hunt (2004) cited in Wilby (2007: 31) argues that there is an "urgent need for energy efficient infrastructure and changed patterns of resource consumption".

However, "while stronger mitigation measures are critical, it is increasingly clear that we are now entering a period of hard consequences, requiring urgent adaptation measures", (Khoday, 2007: 3). Khoday (2007) states that even if drastic climate change mitigation measures were introduced today, climate change impacts and trends will continue posing severe risks to humanity in the future decades. Because climate change will continue to affect low income nations even if mitigation efforts of reducing emission were to start immediately, success in dealing with climate change will have to include a great deal of adaptation (UNDP, 2007). Furthermore, the IPCC (2007) argues that it is understood that even the most applied climate change mitigation attempts cannot evade future impacts of climate change making climate change adaptation essential in short term and medium term periods. This highlights a need for both mitigation and adaptation strategies to be used in tandem for success in promoting future resilience to climate change. Climate change mitigation is suitable for long term reduction of the rate of climate change, whereas adaptation is about enabling resilience to the expected impacts of climate change within short to mid-term periods (IPCC, 2007).

Even more specific on cities adaptation strategies which refers to altering current natural or human systems to be able to withstand the effects of climate change (IPCC, 2007; Scheraga and Grambsch, 1998). The IPCC (2007: 750) defines climate change adaptation as an "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". "Planned adaptation to climate change means the use of information about present and future climate change to review the suitability of current and planned practices, policies, and infrastructure" (Füssel, 2007: 268). Because climate change is inevitable and already occurring, adaptation allows for reduced impacts of the effects of climate change.

However, Friesecke et.al. (2012) argues that although climate change adaptation can evade negative impacts of climate change, it cannot prevent all adverse effects from occurring. This calls for an integrated use of strategies together with climate change adaptation strategies, to promote resilience to climate change (Scheraga and Grambsch, 1998). The UN-Habitat (2011) maintains that a focus on promoting urban resilience should include urban development, addressing inequality (gender and socio-economic), and governance structures as important factors of adaptive capacity and actual adaptation action.

Adaptation has predominantly been perceived as an environmental issue handled by environmental departments and policies (Peltonen et.al., 2010). However, adaptation planning has begun to take into consideration socio-economic impacts of climate change and thus a need to create adaptation plans (Peltonen et.al., 2010). It is now understood that adaptation to climate change cannot succeed if socio-economic factors resulting to increased vulnerability are not dealt with.

2.6 The Role of Planning in Climate Change Adaptation

Urban planning certainly plays an important role in the potential success of climate change mitigation and adaptation strategies (Friesecke et.al., 2012). Urbanization is not only a source of risks because through urban development, resilience to climate change

can be Increased (UN-Habitat, 2011). For instance, while increased population densities in urban areas result to vulnerability, they also create the potential for changes in behaviour to limit human contributions to climate change and make it easy to plan for climate change adaptation (UN-Habitat, 2011). Because the built environment significantly adds to climate change and health outcomes, alternative practices offer opportunities for reduced impacts of climate change (Younger et.al., 2008).

Friesecke et.al. (2012: 6) argues that "facing issues such as climate change, the dimension of limited sprawl and tendencies towards more congestion and spatial bundling of settlements gains new importance". Here, high urban densities are seen as an opportunity to promote resilience through urban development. "Population densities can create the potential for city-scale changes in behaviour that can mitigate human impacts upon climate and create opportunities for adaptation to floods, heat waves and other climate hazards" (UN-Habitat, 2011: 15).

Through urban planning, an area with high densities allows for adaptation plans to be effectively administered than in a city with high levels of sprawl. Urban planning can transfer targets towards new energy-efficient structures and systems, sustainable settlement structures and movement systems into the spatial dimension (Friesecke et.al., 2012). The goals of urban planning are to create a compact and energy-efficient settlement structure that encourages mixed uses, while reducing demand for transportation. In addition, "urban planning with respect to the development of urban settlements play an important role in disaster risk management" (Friesecke et.al., 2012: 7). Attempts to adapt to climate change can also be integrated into city development plans.

According to Moser and Satterthwaite (2008) it is easier for cities with effective development plans to formulate and implement adaptation plans as it allows for the identification of key intervention points for climate change adaptation within development strategies. For success of integrating adaptation into development, engagement of powerful stakeholders in cities is crucial (Moser and Satterthwaite,

2008). However, in the current global reality where most city plans prioritize economic growth and the necessary associated infrastructure, greater engagement is likely to be in local governments already prioritize pro-poor development, environmental issues and/or disaster preparedness (Moser and Satterthwaite, 2008).

Spatial planning, offers nations and cities with possibilities to create cities and settlements that are resilient to climate change effects. Mills (2006) cited in Wilby (2007: 31) maintains that there has been "a growing desire by planners and architects to develop settlements and construct houses that are more energy and water efficient, and simultaneously reduce risks to human and environmental health". Spatial planning has the potential to provide for quality infrastructure and services to vulnerable groups of people in cities, which would reduce vulnerabilities to climate change.

According to the IPCC (2007) sustainable development has the potential to reduce vulnerabilities to climate change by creating settlements that are capable of withstanding the impacts of climate change and increasing resilience. Arguing in the context of developing areas, Taylor and Peter (2014) argue that the effects of climate change cannot be easily separated from other challenges that affect poor urban African household budgets and livelihoods. Therefore "planning and undertaking 'climate compatible development' in African cities must accommodate this reality, accounting for a broader set of interconnected vulnerabilities and development priorities" (Taylor and Peter 2014: 3).

Although at present planning for sustainability rarely includes climate change adaptation or ensuring that the global nations are ready to withstand the impacts of climate change, the need to include climate change issues in development is being recognised (Taylor and Peter, 2014). Taylor and Peter (2014: 2) argue that "the idea of 'climate compatible development' is gaining ground in international policy circles aimed at fusing the climate change adaptation and mitigation agendas with the mainstream development agenda". Adaptation has a role to play through introducing alternatives to the way things are currently done, (e.g. mechanical air conditioning alternatives such as

passive ventilation, building design, planning, green roofs, etc.) and should be the focus of new design guides (Shaw et al, 2007 cited in Hunt and Watkiss, 2007).

Adaptive adjustments in practices, processes, or structures of systems will have to be introduced to reduce sensitivity of systems to climate change or to exploit new opportunities (Scheraga and Grambsch, 1998). However, “few plans for promoting sustainability have explicitly included either adapting to climate change impacts, or promoting adaptive capacity” (IPCC, 2007: 20). Appropriate urban planning can assist with restricting growth of population and activities into risk prone areas (UN-Habitat, 2011) thereby reducing urban sprawl which would add to lack of services thereby resulting to increased vulnerabilities. Furthermore, “infrastructure developments can provide physical protection” (UN-Habitat, 2011: 3) from extreme weather events such as storms and resulting floods.

Development as a result of population growth has a huge role in climate change. Therefore, in response to climate change, development can play an important part in promoting climate change mitigation and adaptation. “Climate change is part of a larger web of issues involving interactions between development, population and environment and it is critical that decision-making aimed at integrated mitigation and adaptation efforts be situated within this broader picture”. UNFPA (2008: 1). Viewed simply, climate change is ultimately a result of pressures placed on natural systems by human activity and development efforts, especially over the last few decades (UNFPA, 2008). Population growth drives urban development which results to increased pressures on the natural environment. For instance, the UNFPA (2008) argues that because population dynamics influence development efforts as both cause and effect, they add to the forces affecting the environment in various ways.

Local area adaptation planning is important because different places around the world are affected differently by climate change rendering a general adaptation plan difficult to achieve. According to Friesecke et.al., (2012) worldwide urban planning systems are diverse and natural and socio-economic aspects of responses to climate change are

different from one place to the next, making the design of general plans virtually impossible. In addition, planning strategies differ from place to place, and thus adaptation plans should be created to be well integrated into local area plans for a specific area.

2.7 Constraints and Limitations to Climate Change Adaptation

One of the limiting factors hindering progress with tackling climate change in South Africa is the extent to which climate change is largely seen as an environmental issue, separate from development (Taylor et.al., 2013). "The National Adaptation Programmes of Action on climate change developed by governments within the least developed countries were developed primarily by ministries of the environment – not ministries of housing or public works or local government (all of whom will have key roles in adaptation" (Moser and Sutterthwaite, 2008: 5). This has meant that most of the scientific knowledge generated has focused more on climate change impacts on natural systems and agriculture than on human settlements and the built environment (Moser and Sutterthwaite, 2008). This highlights "an urgent need to translate awareness of climate change impacts into tangible adaptation measures at all levels of governance" (Wilby, 2007: 42). Therefore, urban planning could be used to integrate climate change adaptation into a greater number of government bodies and thus into broader strategies.

The omission of climate change in development practice is also the case at a local area scale where many urban development tools and policies rarely include climate change. Because in practice climate change continues to be addressed separate from economic growth and the provision of public services, "adaptation efforts tend not to feature as a systemic element of municipal planning and budgeting" (Taylor et.al., 2013, 66).This highlights a need to better integrate climate change adaptation into spatial planning and development. An effective climate change response requires economic, social and environmental interventions that integrate adaptation into a developmental framework (RSA, 2010).

Although many cities have begun engaging with climate change, there is still hesitation to invest in promoting resilience. According to Lamia and Robert (2009: 13) although climate change mitigation and adaptation policies require significant investment, “delaying action can increase future costs and limit future options for adapting to climate change impacts or reducing emissions in cities”. Most strategies that have been used by cities are responsive to climate related disasters that attempting to prevent the occurrence of severe events. “City-scale initiatives are currently focused on awareness-raising rather than impact assessment and adaptation analysis, with the potential consequence that no-regret adaptation options which increase the resilience to climate change are being missed” (Hunt and Watkiss, 2007: 3). As a result, the rate of climate change adaptation planning has been slow. “Therefore, it is essential that human systems, including cities, develop adaptation responses to avoid the risks posed by, and to take advantage of the opportunities arising from, unavoidable global climate change” (Hunt and Watkiss, 2007: 9).

The costs of modifications to urban physical infrastructure and behaviour changes are high which limits adaptation actions in cities. Adaptation is made difficult because “modifications to urban infrastructure and the built environment are expensive, technically unfeasible and/or occur incrementally over long periods of time” (Friesecke et.al., 2012: 9). However, there have been adaptation actions undertaken in cities around the world, with progress in both adaptation planning and implementation. “One emerging theme is that even in the most developed examples, there is little robust appraisal of adaptation options, serving to emphasise that cost-effective and proportionate responses are not yet being identified” (Hunt and Watkiss, 2007: 3). In addition, uncertainties about the future climate changes and the resulting impacts on cities may pose some challenges in terms of the cost of future adaptation. Governments are faced with the “trade-offs between current priorities and long-term risks, a situation compounded by the uncertainties that may surround the timing and severity of climate-related impacts in a city” (Rosenzweig et.al., 2011).

There are concerns about implementation of climate change adaptation plans in a global reality where there are different political inequalities, social groups without access to decision making mechanisms in cities are likely to receive limited benefits from adaptation actions. “It is predicted that even where regions on the whole may be able to successfully adapt to a limited climate change, specific individuals and communities could still be displaced and harmed by climate change” (EPA, 2009: 6). This is likely to be the case in countries with massive resource constraints and thus remain highly vulnerable to climate change. Another fact is that especially in developing countries local governments are often too weak or ineffective to reduce climate change risks and impacts at the urban level (Friesecke et.al., 2012: 9).

2.8 Conclusion

To sum up, this chapter has introduced climate change and climate change adaptation and showed climate change in urban contexts. Climate change will affect low-income cities more that more developed cities, although some effects such as severe weather events will also affect cities in developed nations. In addition, vulnerability to climate change is high in cities of developing nations where urban population densities are also high. Vulnerabilities to climate change is also worsened by other factors in a certain location, for instance, socio-economic challenges, city location (whether inland or coastal) and availability of resources for a city to adapt to climate change. The review went on to discuss climate change in Cape Town before discussing the role of planning in climate change adaptation and constraints and limitations in successfully adapting to climate change. The following chapter presents the research methods undertaken in gathering additional information that will inform the development of a local area adaptation plan in this dissertation.

CHAPTER 3 LOCAL AREA CONTEXT FOR CLIMATE CHANGE ADAPTATION

Introduction

This chapter describes the status quo of the study area of Khayelitsha, highlighting key areas of intervention (with a spatial plan) in an attempt to reduce the area's vulnerability to climate change. The chapter is made up of 4 sections beginning with an environmental analysis section which is made up of hydrology, biodiversity, and climate systems. The second section of the chapter is the human settlements section which consists of a demographic profile, socio-economic profile, social facilities, infrastructure and services as well as key development priorities. Thirdly, the chapter outlines the legislative and institutional context of Khayelitsha, followed by the last part that consists of a review of policies that are relevant to climate change adaptation.

As outlined in chapter 2 of this dissertation, climate change is likely to have an impact on ecosystems and on social and economic sectors (EPA, 2014). Many changes to climate conditions are already being observed in Cape Town with increasing impacts of climate change predicted in the future. Furthermore, given that vulnerability to climate change is connected to the environmental and socio-economic state of an area (IPCC, 2014), areas with poor socio-environmental resources will be highly at risk from changing climate conditions. Although different areas within a region may be exposed to the same climate risks, the sensitivity and vulnerability of different groups to impacts of climate change will vary depending on the socio-environmental state of those areas (Agrawal, 2008). Thus the degree to which an area is affected by climate change will depend on location specific factors, thus although climate change is a global phenomenon, climate adaptation is certainly local (Agrawal, 2008). This necessitates a local context study of an area to gain an understanding of the resources, strengths and vulnerabilities that would inform locally relevant adaptation response strategies aimed at protecting communities from the impacts of climate change.

Therefore, the purpose of this chapter is to outline the status quo of the study area of Khayelitsha through identifying key trends that will be important informants for the development of the climate change adaptation plan for the study area. This chapter will strategically identify existing opportunities to build the adaptation plan upon, and risks that require interventions to reduce the effects of climate change in the area. This will help with identifying priority areas and suitable actions to promote climate resilience and reduce the effects of future climate changes to local communities.

This chapter will also provide an outline of the current policies and institutions that influence climate change adaptation in Khayelitsha, with a vision to harmonise climate change adaptation with spatial planning processes. To this end, it is hoped that the analysis will aid with informing interventions that will be proposed in the adaptation plan, in an attempt to enhance current planning policies; by integrating climate change adaptation strategies into local area spatial planning interventions to reduce vulnerability to climate change in Khayelitsha. This chapter draws from existing analysis of the study area conducted by the City of Cape Town in 2011 for the Khayelitsha/Mitchell's Plain district plan Baseline information and analysis report. The Khayelitsha/Mitchell's Plain district plan will be used as a main source of data from which the analyses in this chapter is based. This will enable for opportunities and constraints to be identified and translated into a spatial plan for climate change adaptation in chapter 4.

3.1 Environmental Analysis

An analysis of natural systems is an essential point of departure for climate change adaptation planning as it would guide the key protective and resource management actions that will be proposed in the adaptation plan. Because of the relationship between human systems and natural environment (figure 3.1), natural resources are important for the sustainability of communities now and in the future (Marten, 2001). Therefore, a climate change adaptation intervention should include the management and protection of natural systems as an important asset for moderating future climate

risks as well as opportunities that can be exploited to promote resilience to climate change.

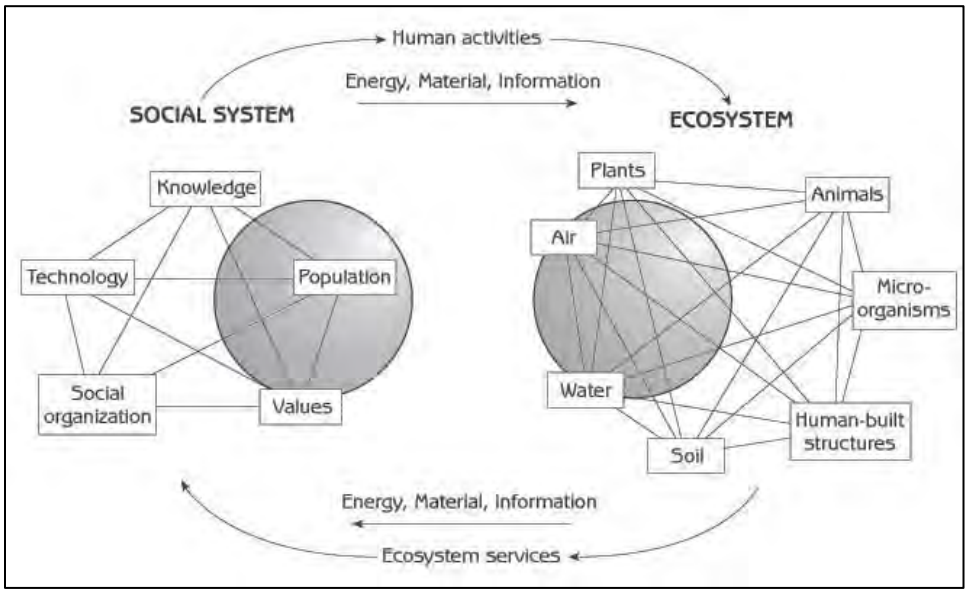


Figure 3.1: Interaction of the Human Social System with the Natural Ecosystem. (Source: Marten, 2001).

In light of the threats that arise from the changing climate conditions leading to increased vulnerabilities to human communities especially in poorer areas, natural systems present a foundation to which resilience to climate change and related natural disasters and hazards can be built upon. This environmental analysis aims to evaluate the context of the study area to identify opportunities that will help with the creation and implementation of the adaptation plan in Chapter 4. Thus this analysis will identify key environmental systems threatened by human settlements in the area which will guide the decisions that will form the proposed interventions.

3.1.1 Aquatic Systems

Water is the source of life of the planet earth and forms the source upon which natural, social and economic systems depend on. According to WWF (2014) water availability is one of the most significant factors that will most likely determine the economic, social and environmental well-being of South Africa over the next decade, and its quantity is already limited with an increased demand for fresh water resources. As a result of changing climate conditions which leads to changes in the quantity and availability of

water resources, ecosystems are affected and thus the well-being and livelihoods of societies that depend on them. Climate change is significantly affecting the hydrological cycle resulting to changes in water availability as well as natural and human systems demand for fresh water resources (UN-Water, 2010). Therefore, the management of water systems is crucial for creating resilience of communities to climate change.

a) Rivers and Wetlands

The area has an aquatic systems including a major river system that falls into the north-eastern part of the study area and wetlands making up surface water (map 3.1), as well as a ground water system. The surface water system in the study area consists mainly of the river (Kuils River) and the wetlands. However, these water reserves (including all water systems that form the hydrological cycle) are threatened by human urban settlements mainly in form of residential development in Khayelitsha which affects water quality as a result of increased water pollution which adds to increased chances of a shortage of freshwater resources in the future. Water quality refers to the suitability of water reserves to serve aquatic ecosystems as well as water usability by natural systems and human settlement. Because water systems are linked, pollution of one part for instance the river will affect other parts such as ground and sea water systems.

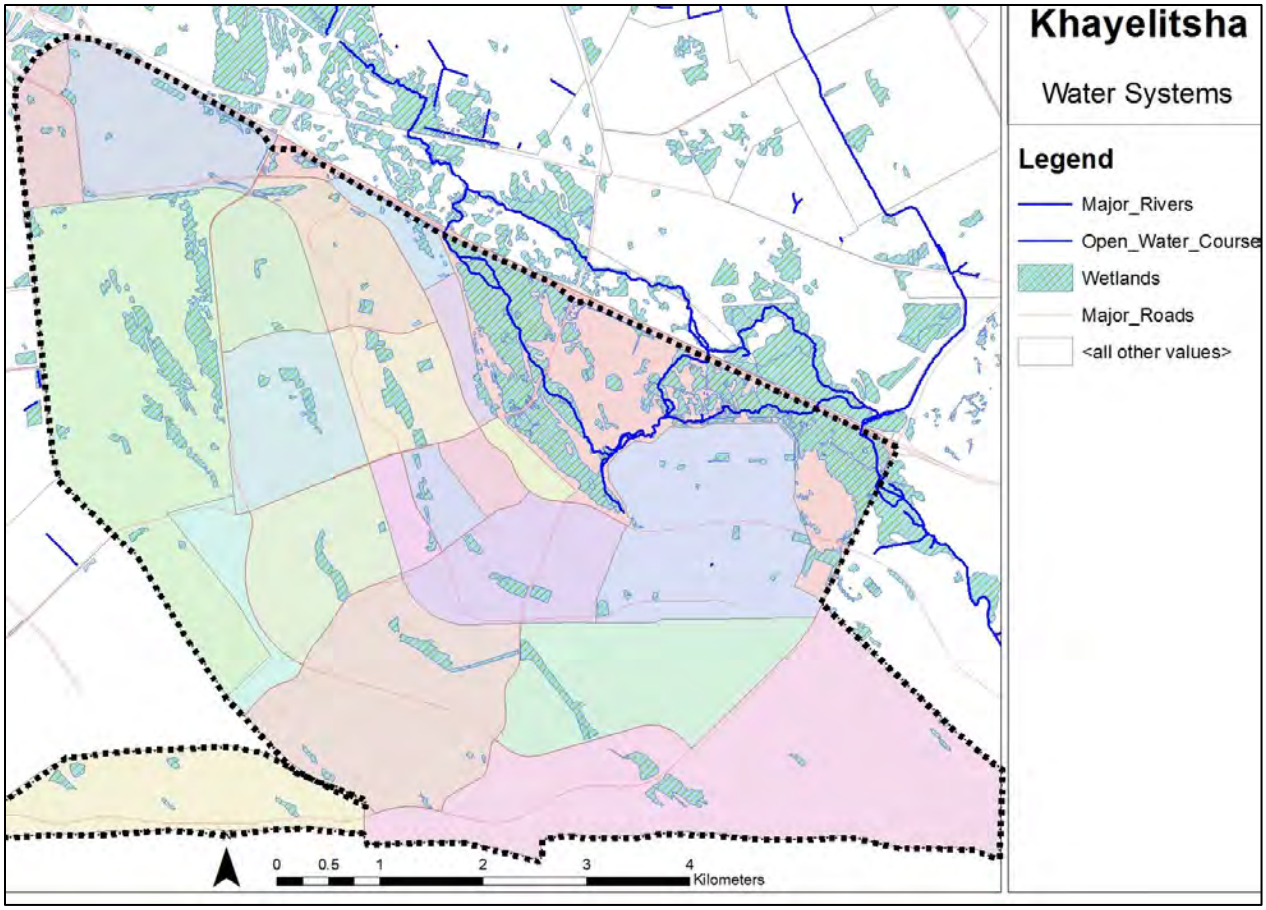
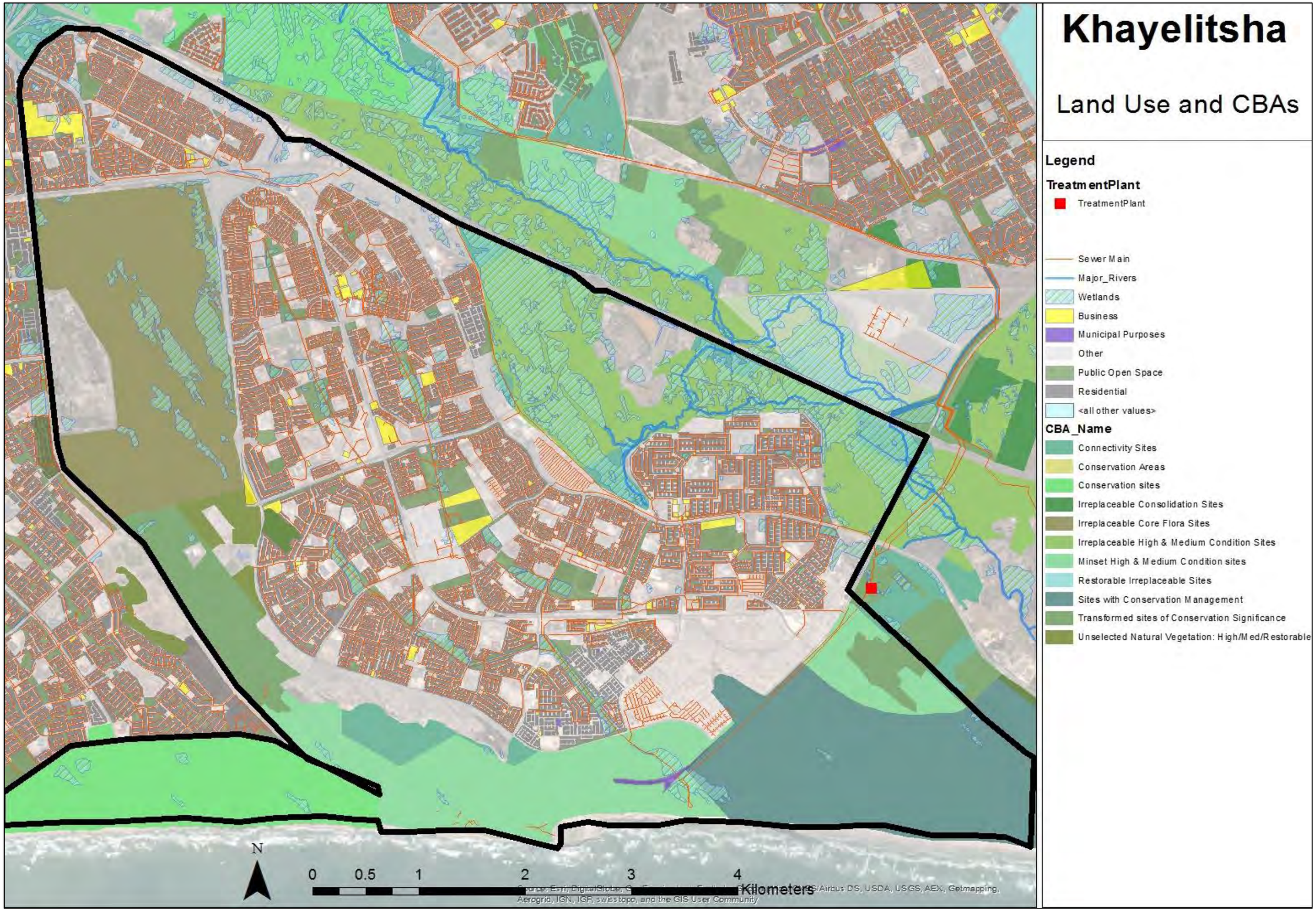


Figure 3.1: Kuils River and Wetlands in Khayelitsha. (By Author. Source: CoCT GIS data 2013).

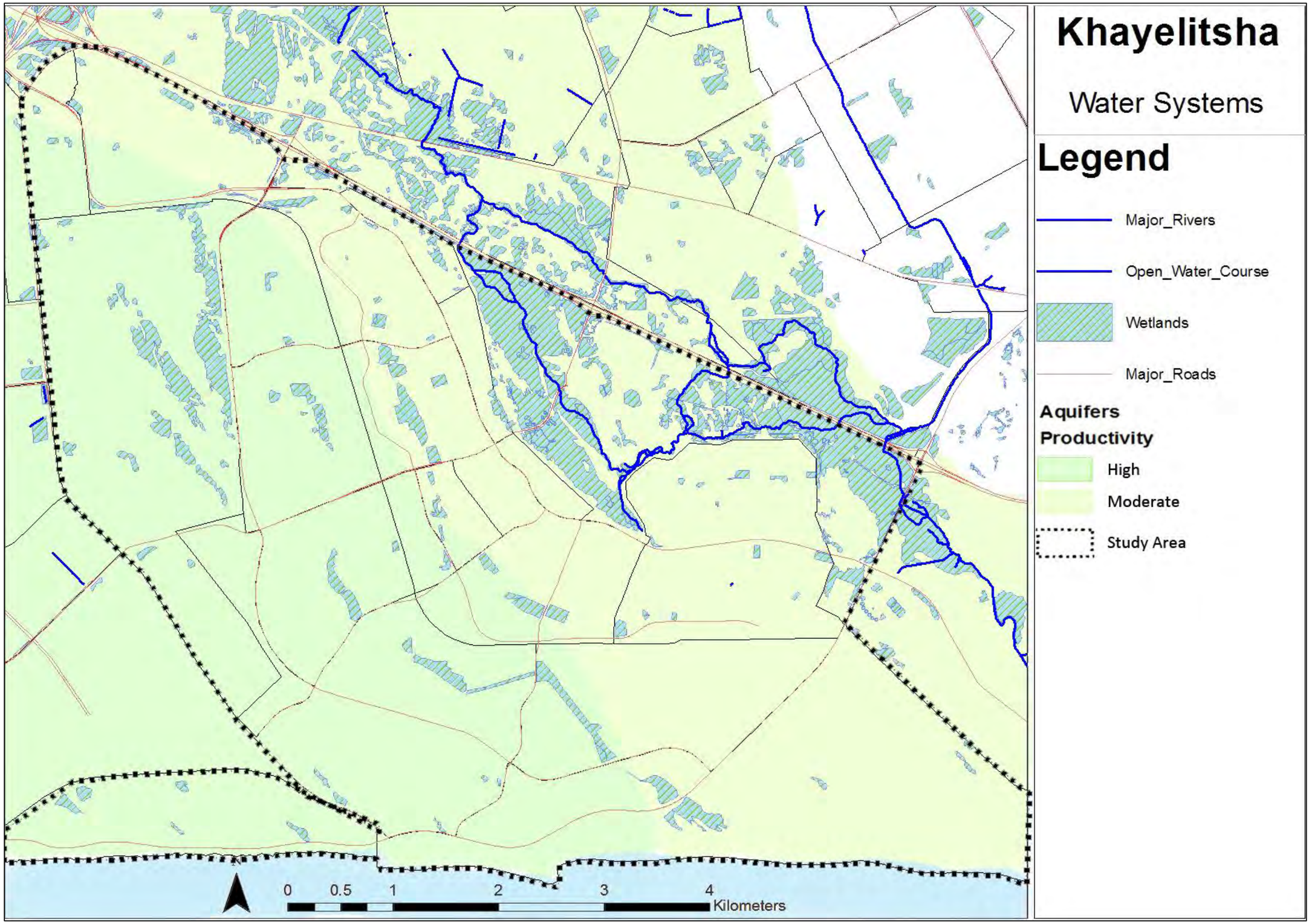
Furthermore, the Kuils River has largely been canalised and modified from its natural form as a result of rapid urban growth in the area. Urban growth also led to the filling of wetlands and flattening of dunes to create space for urban development in Khayelitsha, with some infrastructure such as sewer pipes and waste water treatment plant (Map 3.2) located in close proximity to the water systems in the area (CoCT, 2011). This resulted to the decline of water quality in the surrounding wetlands and the Kuils River and its tributaries.



Map 3.2: Interface between Human Systems and Natural Systems. (By Author. Source: CoCT GIS data 2013).

b) Groundwater Reserves

Khayelitsha is part of the Cape Flats aquifer recharged mainly from precipitation within the Cape Flats (CoCT, 2011). With the increasing water constraints in the City of Cape Town metropolitan area, the Cape Flats aquifer has been identified as a potential source of water to supplement the overall water resources of the city (CoCT, 2011). This is highlighted by the high recharge aquatic area on the water systems map 3.3. However, due to urban development these aquifers are under threat from pollution from human settlements and land uses in the Cape Flats area. Most water resources such as in rivers and wetlands have been affected by urban development in Khayelitsha, yet the main parts of the aquifer has some significant fresh water reserves remaining. The aquifer has been affected by urbanisation but is still identified and regarded as an option for future water supply for the City of Cape Town (CoCT, 2011).



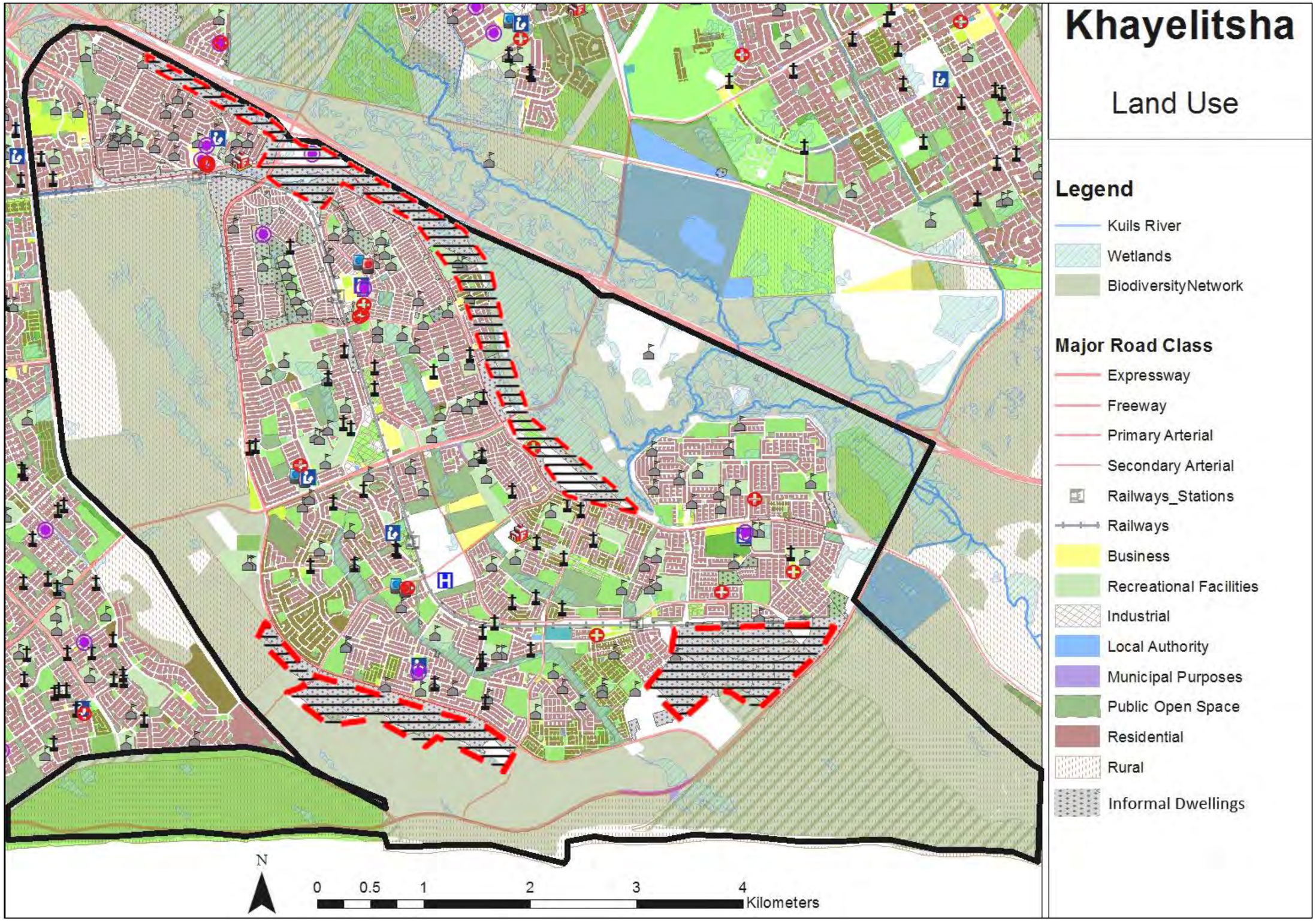
Map 3.3: Khayelitsha Water System. (By Author. Source: CoCT GIS data 2013).

c) Risks and Hazards Associated to Water Systems in the Area

Floods

Low lying areas of Khayelitsha are located on a floodplain which results to increased prevalence of floods in the winter season every year. Flooding occurs in the area due to the pattern and location of settlements near these low-lying areas close to the Kuils river flood plain, with some significant number of informal settlements located in the disaster prone areas as shown on map 3.4 (CoCT, 2011). Floods also occur as a result of ground water discharge during the rainy winters. Because Khayelitsha is located in a coastal area, there are also future threats arising from sea level rise which would result to floods in low-lying areas as a result of storm water surges. The frequency of floods in some parts of Khayelitsha causes significant damage and loss of property and in some cases loss of life in the area.

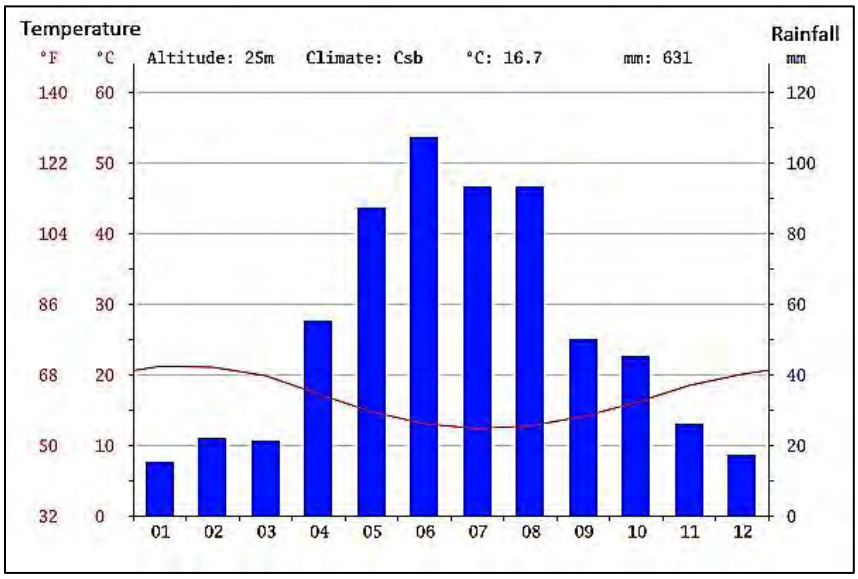
In addition, the socio-economic impacts of flooding in Khayelitsha include damage to infrastructure, housing, personal belongings. When coupled with the social challenges of underdevelopment and economic levels in comparison to wealthier parts of the city, these damages present further socio-economic stresses resulting from costs of rebuilding and replacing lost property and infrastructure. Furthermore, with limited financial resources for municipalities in South Africa as is the case in Cape Town, flooding results to an additional cost through flood risk management spending and infrastructure repairs.



Map 3.4: Land Use and Areas that are at high Risk from Climate Change Events. (By Author. Source: CoCT GIS data 2013).

Drought

South Africa is a semi-arid country recording an annual average rainfall of 450mm, just over half of the recorded global average rainfall at 860mm (Wilson, 2011). Given the current population growth and the high rate of urbanisation, extreme water scarcity is a likely scenario (Wilson, 2011). The Cape Town municipal area receives seasonal rainfall in winter which results to droughts in dry summer seasons (Graph 3.1). This results to decreased water resources during dry summers in the area. The adaptation plan proposes water quality and quantity management to ensure that existing water resources are sufficient for providing water security to local communities. Also, with continued pollution of water resources in the Kuils River to the North East of Khayelitsha (River Health Programme, 2005) as well as the Khayelitsha wetlands, there is a risk of increased water shortages in the future, whereby most water resources in the area could be polluted and unsuitable for sustaining biotic systems and human settlements.



Graph 3.1: Cape Town Annual Climate Cycle. (http://en.climate-data.org/location/27088/).

Furthermore, the changing global climate conditions brings about changes in rainfall patterns, thus high rainfall periods over short periods of time are expected which would result to increased chances of floods in the rainy seasons and droughts in the dry seasons (Trenberth, 2011). These changes in amount, intensity, frequency, and type of

precipitation will further exert stain on the environment and society (Trenberth, 2011), especially in poor areas that usually depend on natural ecosystems for their livelihoods.

d) Management and Preservation of Water Resources

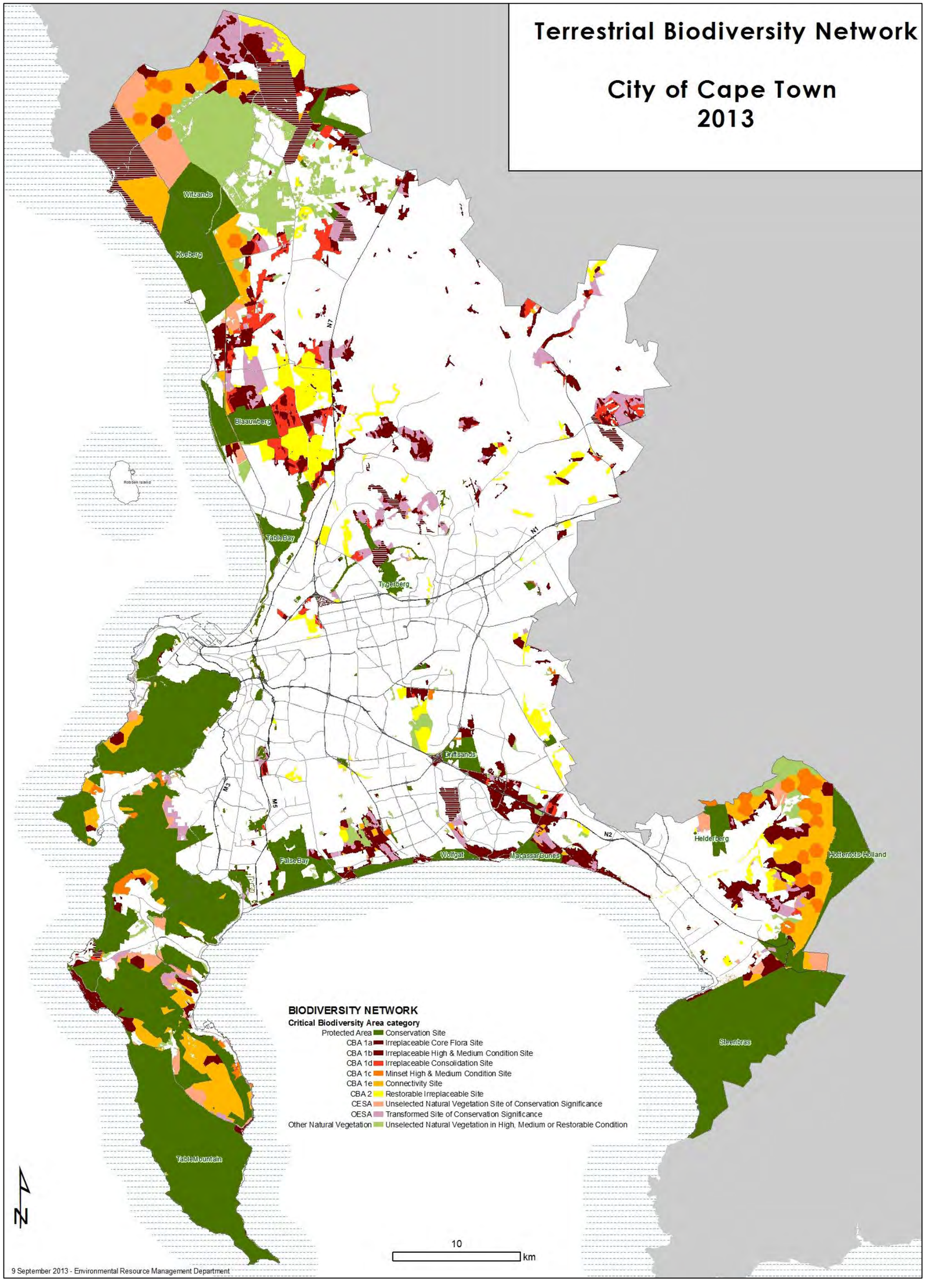
The development of Khayelitsha resulted to the canalisation of the Kuils River in an attempt to reduce the likelihood of floods in human settlements developed (CoCT, 2011). Storm water drainage systems were also installed to channel storm water flow from settlements into the river system and the sea. In addition, Khayelitsha has two main storm water collectors that flow to the South-East through the middle of the water catchments into the main exit canals (CoCT, 2011). These storm water collectors add to the reduction of floods and reduce pollution and also collect water for treatment and human settlement consumption. Storm water ponds within the catchment areas of Khayelitsha are important for reducing water pollution from storm water and for reducing floods as they collect water which seeps through into the ground rather than flow into the river. In addition, some open spaces have also been reserved for collection of storm water which also reduces the risk of flooding in surrounding areas (CoCT, 2011). There is also the Khayelitsha wetlands park (Map 3.5) that adds to the protection of some wetlands in the area.

Map 3.5: Khayelitsha Wetlands Park. (By Author. Source: Map from Google Maps, Images from http://www.capetown.gov.za/en/parks/Pages/KhayelitshaWetlandsPark.aspx).

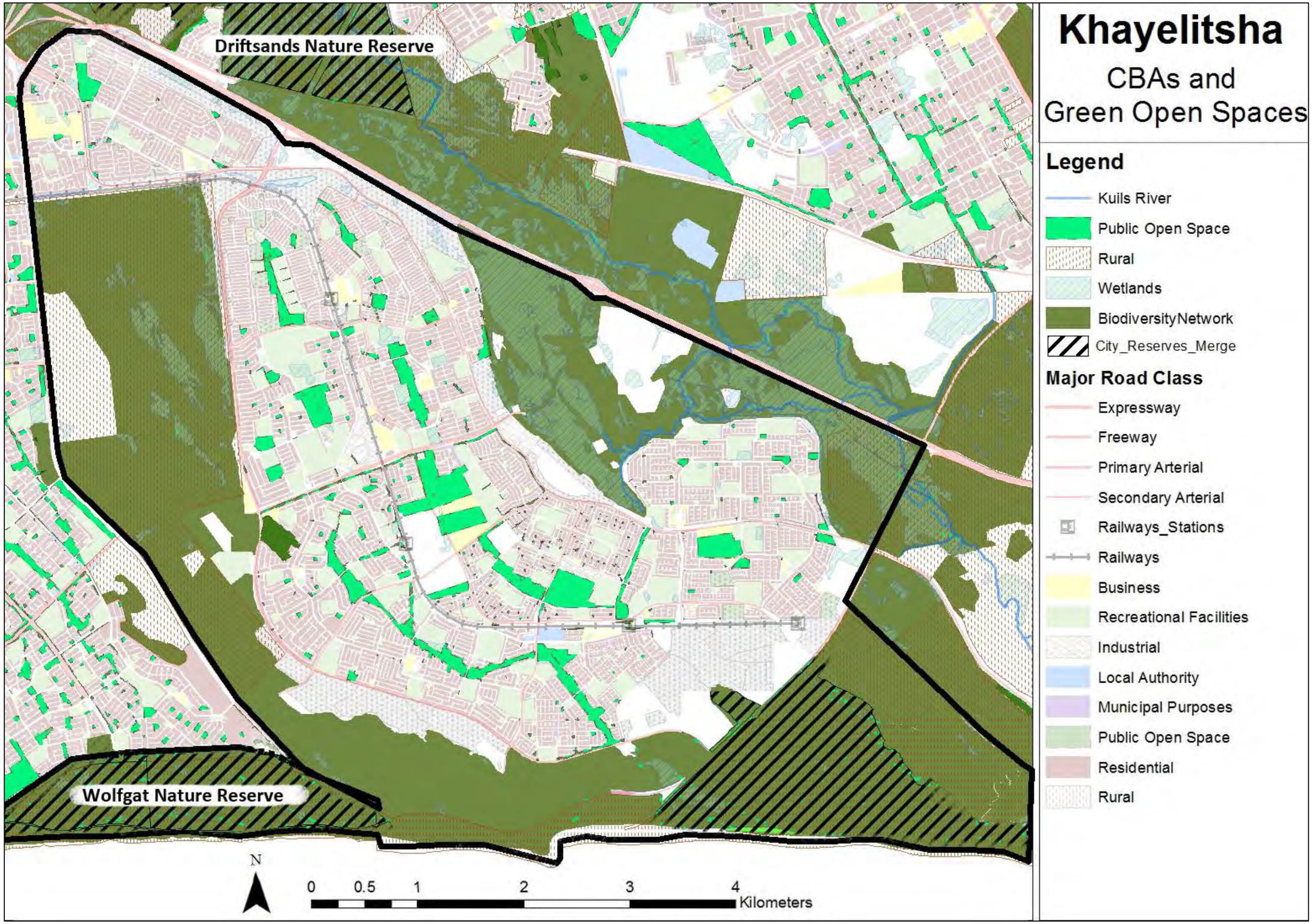
3.1.2 Biodiversity

The City of Cape Town is located in a unique area globally recognised for its rich and significant biodiversity. This drives tourism in the city which adds to economic growth and social development. In 2003, the City of Cape Town committed to launching a Biodiversity Strategy aimed at enabling the conservation of Critical Biodiversity Areas. Critical Biodiverity Areas are features needed for the conservation of biodiversity and for continuous ecosystem functioning and the desire is to keep them in their natural state (BiodiversityGIS, 2014). Map 3.6 shows the Critical Biodiversity Network mapped by SANBI for the City of Cape Town Municipality.

Protection of biodiversity areas is important for maintaining natural systems and can also provide barriers that protect human settlements from extreme weather events that arise as a result of climate change. Most areas of critical biodiversity in the country are protected from human land use in city reserves and national parks as well as protected areas marked as areas of critical biodiversity. However, some of these areas identified as critical biodiversity areas are not protected. In Khayelitsha, although the area has some of the rarest biodiversity resources, they are still threatened by urban growth especially growing informality. The majority of remaining biodiversity areas in the study area are nationally recognised and categorised as irreplaceable core flora sites (See Map 3.6). There are also some categories in identified in the study area such as consolidation sites and natural vegetation sites of conservation significance. The conservation of remaining biodiversity areas in Khayelitsha presents an opportunity to protect some endangered species unique to the City of Cape Town municipal area. Map 3.7 shows biodiversity areas in Khayelitsha including protected city reserves.



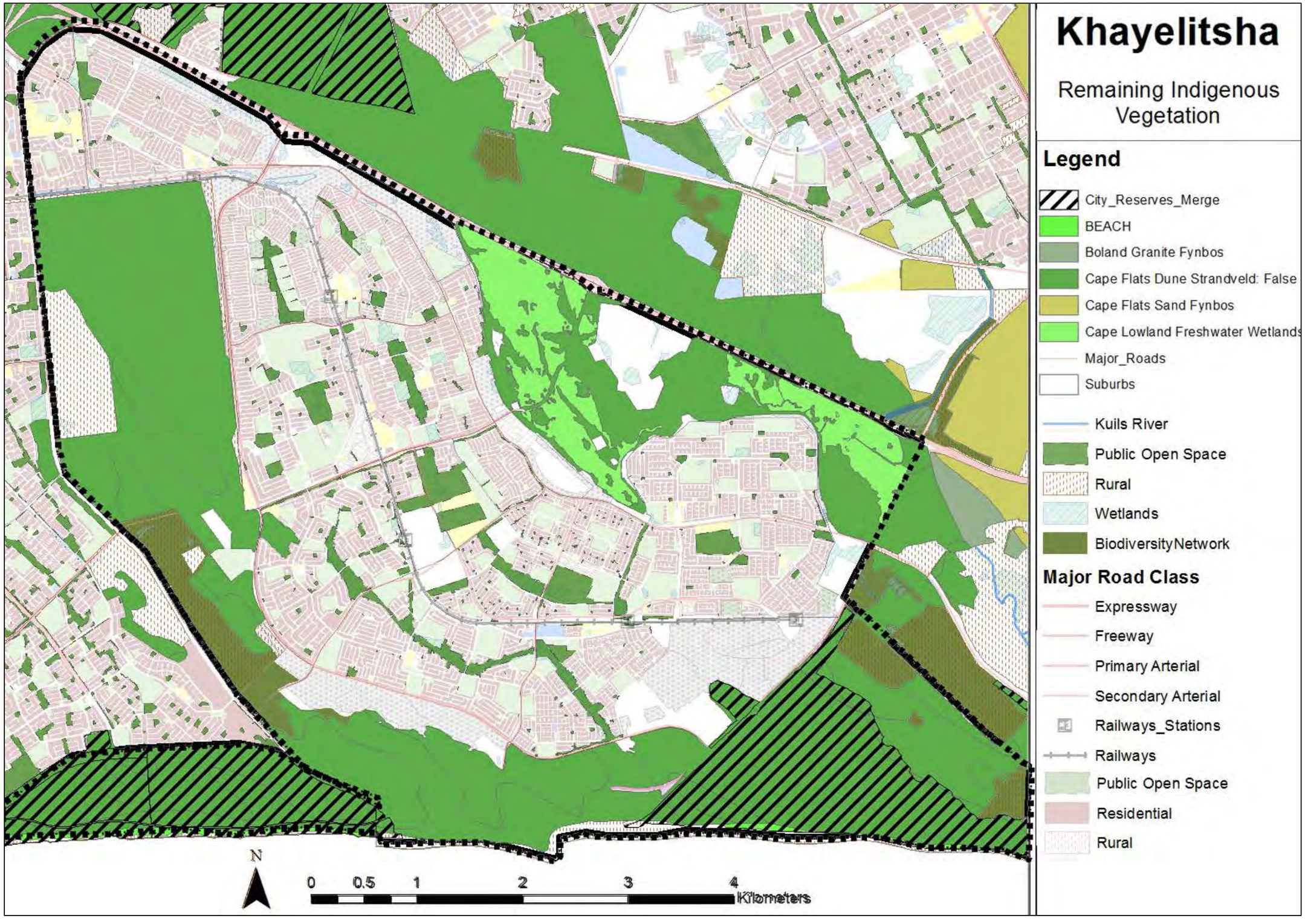
Map 3.6: City of Cape Town Biodiversity Network. (Source: BiodiversityGIS, 2014).



Map 3.7: Critical Biodiversity Areas in Khayelitsha. (By Author. Source: CoCT GIS data 2013)

The City of Cape Town has very high levels of biodiversity within a relatively small area and the remaining biodiversity in the Cape Flats is some of the scarcest plant communities in the Western Cape (CoCT, 2011). Map 3.8 shows the remaining indigenous vegetation in the study area. The majority of the remaining natural areas in Khayelitsha are mostly covered by Cape Flats Dune Strandveld (Map 3.8). This type of vegetation is usually found on flat dune fields and is characterised by tall evergreen, hard-leaved shrubland with some grasses and herbs growing in between the shrubs (CoCT, 2011). The vegetation found in the Cape Flats dunes (the strandveld) is endangered with only 6% conserved. There is also a rare Cape Flats fynbos (Map 3.8) found on sands in the north eastern part of the study area near the wetlands.

In terms of fauna, there is limited information on the specific distribution of fauna within the City of Cape Town region (CoCT, 2011). Some quantifiable lists of species are available in nature reserves around Cape Town. However, there are undoubtedly threatened species in parts of the city area that require identification and protection. For instance, there are two indigenous freshwater fish species currently recognized as occurring within the boundaries of the CCT (CoCT, 2011). There are also ranges of mammal species, bird species, amphibians, reptiles, and insects identified as endemic in the Khayelitsha and the general district F area. These have to be protected as potential assets for tourism growth as well for the functioning of ecosystems in the study area and the rest of Cape Town.



Map 3.8: Remaining Indigenous Vegetation in Khayelitsha. (By Author. Source: CoCT GIS data 2013).

Management and Preservation of Biodiversity

The City of Cape Town recognises biodiversity assets important and requiring protection from human activities. Through the Integrated Metropolitan Environmental Policy (IMEP) adopted in 2001, the city of Cape Town devised strategies for the conservation and protection of critical biodiversity resources. Within its objectives, the City has aligned biodiversity conservation planning to the national planning in compliance with the National Environmental Management Biodiversity Act (No. 100 of 2004) (CoCT, 2011). This has led to the identification of areas of critical biodiversity creating Biodiversity Network or corridor necessary for conserving threatened ecosystems and promoting sustainable urban growth. This analysis identifies the biodiversity network in the study area as an opportunity and a resource that can be utilised to attract tourist visits into Khayelitsha. Furthermore, in light of threats from the climate change and socio-economic challenges in the area, natural systems provide an opportunity that can be built upon for ecosystems services as well as building resilience in the area.

3.1.3 Climate Systems

a) The Context Realities of Climate Change

i) Climate Change in the urban Cape Town

Evidence from different government reports (e.g. national, provincial and municipal plans) show that there are interests in dealing with climate change at national, provincial and local government levels in South Africa with climate change recognised from the National government through to the local government level. South Africa has joined the international community in the fight against climate change. For instance, climate change issues have been included into national policies, acknowledging the need for reducing urban activities that result to climate change as well as responding to future climate changes (RSA, 2010). However, “the notable absence of a national political agenda around climate change (and the natural environment more generally) in

South Africa means there is very little political or fiscal support for local programmes" (Taylor et.al., 2014: 8).

With the projected changes in climate conditions in Cape Town, resources such as water will be decreased. This is the case in Cape Town where a greater share of the water resources is needed to meet the growing demand for water, and new ways of meeting these demands will have to be found in the near future to address the Metropolitan area's water shortages (Mukheibir and Ziervogel, 2006). Other challenges include "water and food in-security, damage to key infrastructure and transport routes, interruption to service delivery, health risks, heat stress, flooding, and negative impacts on the groundwater table, ecosystem health and biodiversity", (CoCT, 2011: 30).

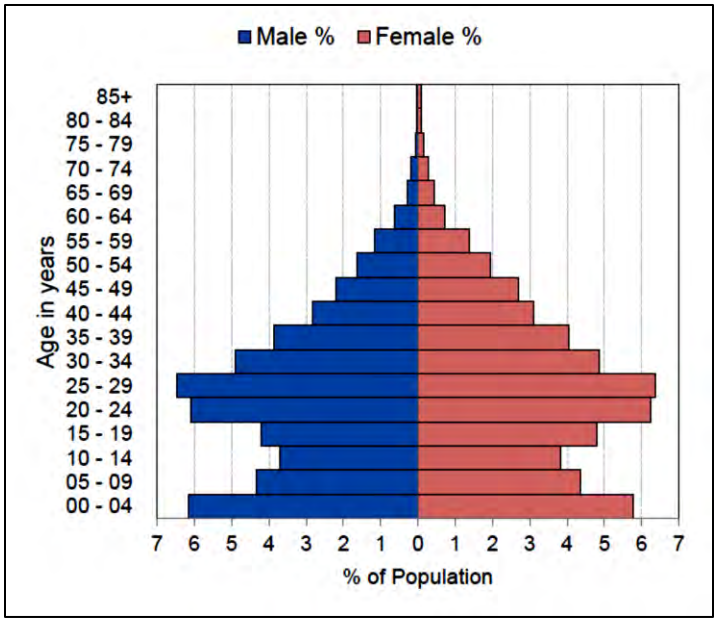
In addition, climate change vulnerabilities in poor areas are going to increase as a result of the slow pace in the delivery of basic services such as adequate housing, health care, and other infrastructure, which will poses more challenges for the city in terms of the services that have to be provided (Mokwena, 2009). Urban informality in Cape Town heightens these backlogs in service delivery, and thus will results to increase susceptibilities to climate change in poor areas.

3.2 Human Settlement Analysis

This section will focus on identifying socio-economic issues in the study area that will form the main departure point of the local area plan. Because vulnerability to climate change is intertwined with socio-economic issues, adaptation to climate change should include an analysis of these human settlement related challenges to inform the plan.

3.2.1 Demographic Profile

The total population of Khayelitsha based on the 2011 census data supplied by the Statistics South Africa was approximately 391 749. The graph below (graph 3.2) shows the population pyramid for Khayelitsha.



Graph 3.2: Population Pyramid for Khayelitsha in 2011. (By CoCT, 2013. Source: Stats SA, 2011)

From graph 3.2, the largest population group is aged between 25 and 29 years and the majority of the population is under the age of 35 years. This shows that the population is predominantly made up of young people. According to the Statistics South Africa (2011) census, the population is mostly Black African making up 386 358 (98.6%) of the total population of 391 749. A fraction of the population aged 20 years and older (36%) have completed Grade 12 or higher (Table 3.1). Over half (62%) of the labour force aged 15 to 64 is employed, showing an average unemployment rate of 38% which is higher than the national average rate at 25.7% and the City of Cape Town average rate at 24% in 2011.

Khayelitsha Adult Education (for all aged 20+)	Black African		Coloured		Asian		White		Other		Total	
	Num	%	Num	%	Num	%	Num	%	Num	%	Num	%
No schooling	6 066	2.5%	45	3.2%	21	12.3%	18	8.5%	327	16.1%	6 477	2.6%
Some primary	23 613	9.8%	219	15.4%	12	7.0%	9	4.2%	156	7.7%	24 009	9.8%
Completed primary	10 662	4.4%	126	8.8%	9	5.3%	6	2.8%	75	3.7%	10 878	4.4%
Some secondary	114 675	47.4%	651	45.7%	63	36.8%	84	39.4%	768	37.8%	116 241	47.3%
Grade 12	74 442	30.8%	327	22.9%	57	33.3%	51	23.9%	585	28.8%	75 462	30.7%
Higher	11 886	4.9%	51	3.6%	9	5.3%	45	21.1%	81	4.0%	12 072	4.9%
Other	411	0.2%	6	0.4%	0	0.0%	0	0.0%	39	1.9%	456	0.2%
Total	241 755	100.0%	1 425	100.0%	171	100.0%	213	100.0%	2 031	100.0%	245 595	100.0%

Table 3.1: Education Levels of Individuals Aged 20 and Above in Khayelitsha in 2011. (By CoCT, 2013. Source: Stats SA, 2011).

Furthermore, the 2011 census results for Khayelitsha show that 74% of households have a monthly income of R3 200 or less. About 45% of households live in formal dwellings with roughly 62% of households have access to piped water in their dwelling and 72% of households have access to a flush toilet. There is also access to refuse removal at least once a week for 81% of households and 81% of households have access to electricity in their homes.

The demographic information from the 2011 census shows that there are some backlogs in access to services such as housing, piped water and electricity as well as education and lack of employment opportunities. These shortages of economic opportunities and sound infrastructure renders communities without access in the study area more vulnerable to climate change that people from other areas. Therefore, when planning for adaptation to climate change, access to infrastructure and socio-economic opportunities become significant strategic points of departure. The demographic analysis findings will be used to inform proposed social and economic interventions in the study area.

3.2.2 Socio-Economic Profile

Climate change will have negative impacts on global social and economic systems. Climate change and related extreme weather events have undermined progress in poverty alleviation and human development efforts (Karfakis et.al., 2012). Livelihoods and economies that depend on weather conditions for instance agriculture and tourism will be subjected to the impacts of climate change. Although it is expected that frequency and duration of hot weather periods will increase, precipitation is expected to decrease (Karfakis et.al., 2012). In Khayelitsha, this would affect local residents in terms of food insecurity and a decrease in tourist visits into the area were some residents earn a living from selling products to visitors from outside Khayelitsha. For example, food security would be reduced as a result of increasing prices due to reduced agricultural production. This would negatively affect low income earning households in the area.

This section will outline key socio-economic factors in the study area that will inform the local area plan and interventions in an attempt to adapt to climate change.

i) Social Characteristics

The Cape Flats area represents some of the most marginalised areas in the City of Cape Town municipal area mostly characterised by low income housing and limited economic activity (CoCT, 2011). The Khayelitsha and surrounding area is known for its social challenges manifested by violent crimes, substance abuse and the prevalence of gang violence. Furthermore, the area has the highest poverty and a low quality of infrastructure and services in the City of Cape Town municipality area, and is characterised by low standards of living with the highest unemployment rate in the City of Cape Town area (CoCT, 2011).

The area had a 19% population increase between 2001 and 2011 (CoCT, 2013), higher than the city's population growth rate of 2.6% during the same decade (Stats SA, 2011). With the increased rate of population growth, housing and service provision backlogs also increase. This is shown by the growing informality where most residents in informal settlements have inadequate access to basic services which is manifested by increasing number and frequency of service delivery protests. There are more informal dwellings in the area (table 3.2) at 54.5% compared to formal dwellings recorded at 44.6% (CoCT, 2013). The majority of households (74%) earn less than R3200 or less per month with the average household sizes of 3.3 people per household (CoCT, 2013). The study area falls in a district (District F) with the highest crime rates and second highest drug related crimes recorded in 2006.

Khayelitsha Type of Dwelling	Black African		Coloured		Asian		White		Other		Total	
	Num	%	Num	%	Num	%	Num	%	Num	%	Num	%
Formal Dwelling	52 186	44.5%	339	69.6%	34	54.8%	62	60.2%	369	46.1%	52 990	44.6%
Informal dwelling / shack in backyard	9 463	8.1%	47	9.7%	6	9.7%	4	3.9%	211	26.3%	9 731	8.2%
Informal dwelling / shack NOT in backyard	54 679	46.6%	95	19.5%	22	35.5%	36	35.0%	198	24.7%	55 030	46.3%
Other	1 028	0.9%	6	1.2%	0	0.0%	1	1.0%	23	2.9%	1 058	0.9%
Total	117 356	100.0%	487	100.0%	62	100.0%	103	100.0%	801	100.0%	118 809	100.0%

Table 3.2: Types of Dwellings in Khayelitsha in 2011. (By CoCT, 2013. Source: Stats SA, 2011).

ii) State of the Economy

Khayelitsha has a lack of economic development with low commercial and industrial property values and activities compared to other parts of the municipal area. Commercial properties account for only 3.6% and industrial properties only 1.1% (Table 3.3), showing the lowest sizes of commercial and industrial activity of all the districts in the City of Cape Town municipal area (CoCT, 2011). Retail property values are higher than office property values showing a high prominence of the retail sector in the district than the office sector. There is also little investment towards economic development in the district (CoCT, 2011).

Count	% Count	Total Property Value (R mill)	% Value	Building Value (R mill)	Land Value (R mill)
289	3.6%	R 850	3.0%	R 551	R 299
Industrial Properties					
64	1.1%	R 61	0.5%	R 43	R 19
Commercial and Industrial Properties (Sum of above 2 tables)					
353	2.6%	R 911	2.3%	R 594	R 317

Table 3.3: Commercial and Industrial Property Values for District F. (By CoCT, 2013. Source: Stats SA, 2011).

3.2.3 Settlement Patterns and Infrastructure

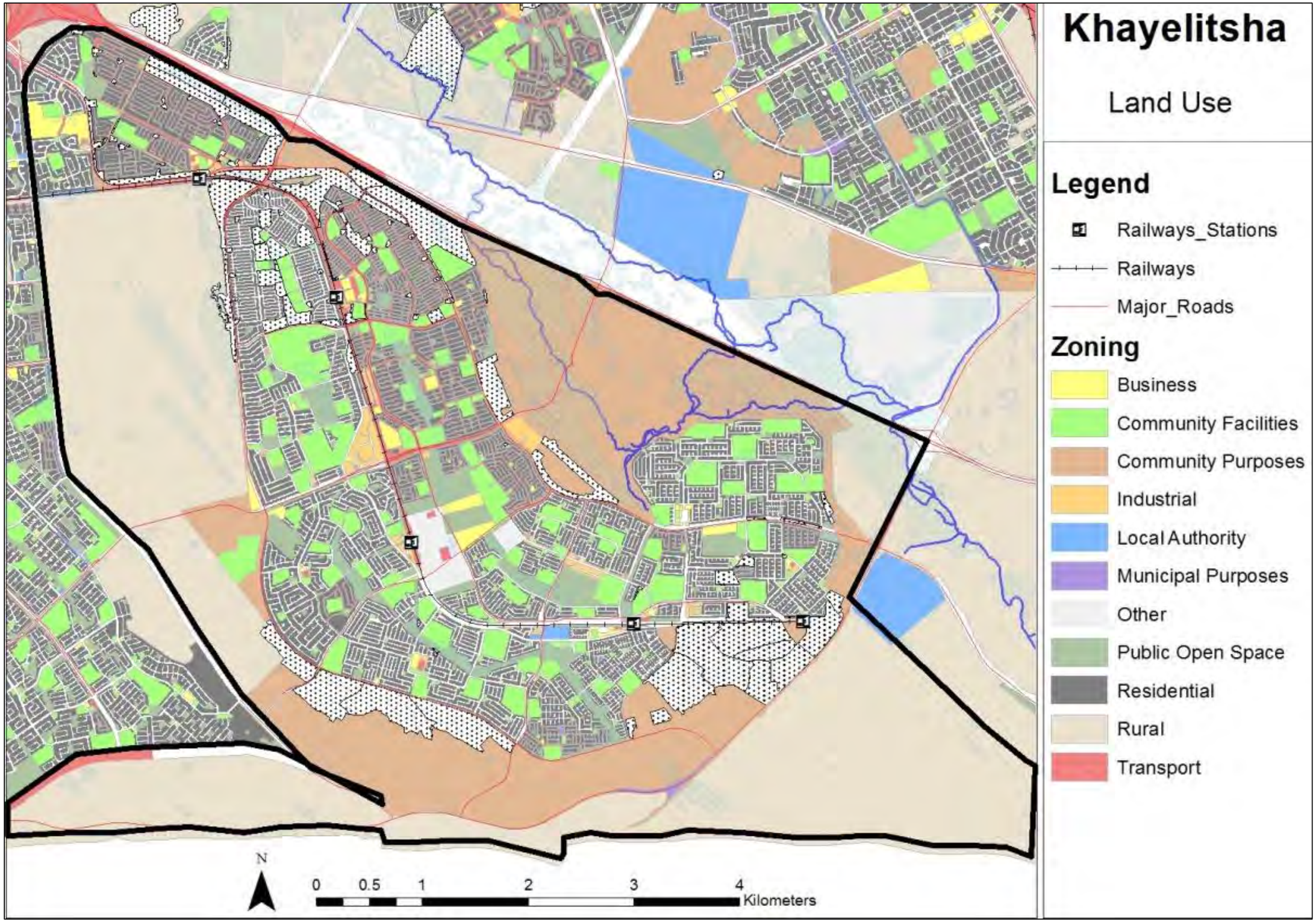
The area has a variety of residential types and forms with a mixture of formal residential properties and informal settlements (Map 3.9). The land use map (map 3.9) also shows that the area is accessible by road and rail with a major road located to the north of the study area linked with connector roads that cut across the study area linking the settlement to the major road. There is also a railway line through the middle of the area which serves as a commuter train route into Khayelitsha. The existing railway line and roads offer potential for transport of goods and people which can be exploited when promoting economic development. However, although there are existing pedestrian movement routes in the area, crime rates constrain the use of these routes especially at night.

The majority of land is used for residential purposes (both formal and informal) and strips of community facilities and public open spaces cuts through the middle of the area forming green corridors. These green corridors are important for conserving natural processes, including the dispersal and relocation of plants and animals, necessary for replenishing and conserving species and maintaining eco-systems in the long-term (CoCT, 2011). The growth of informal settlements increase challenges to the provision of appropriate housing to all residents in the area. In addition, because of the high densities and number of residential settlements in the area, the amount of vacant land for future residential development is limited (see Map 3.10).

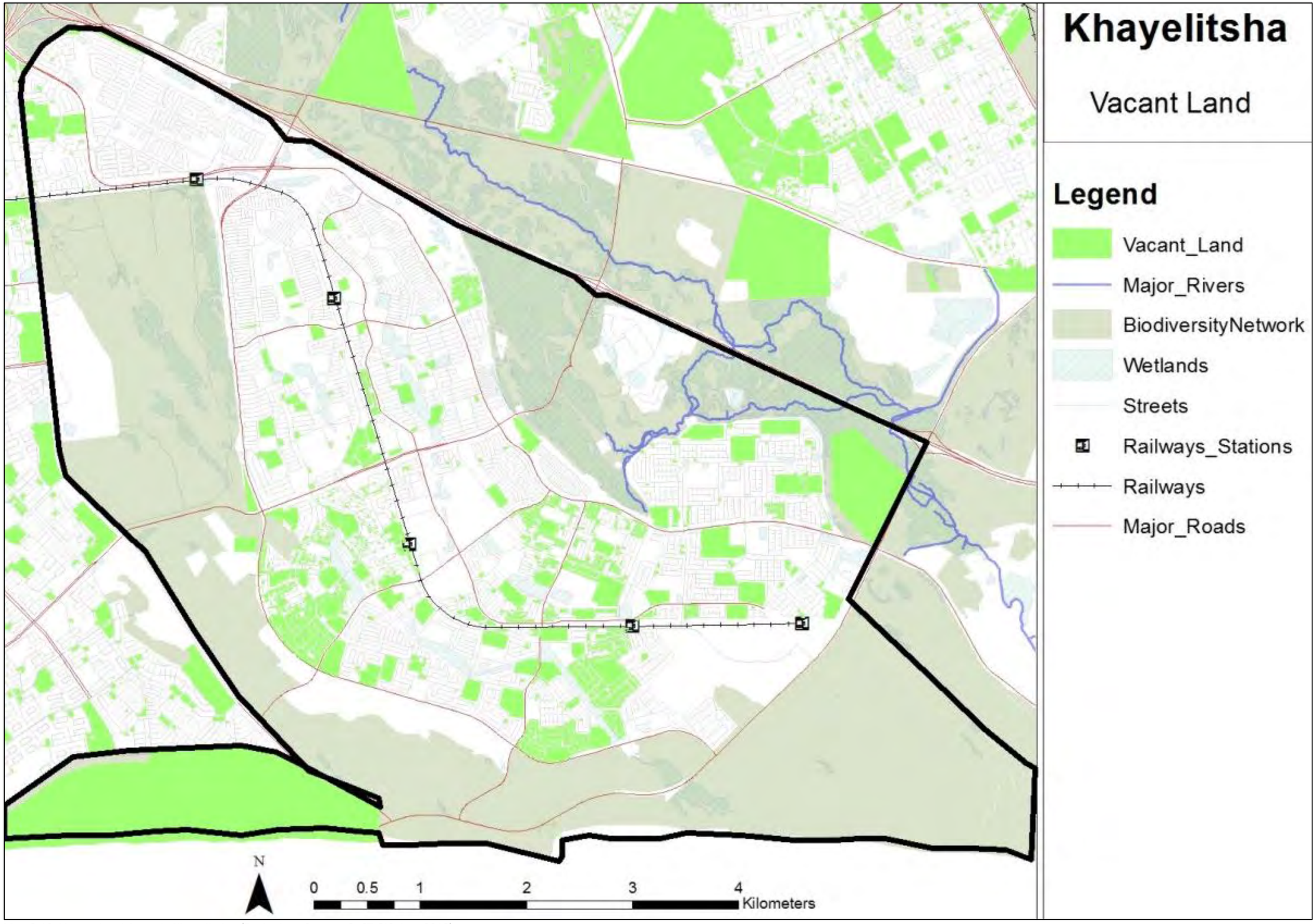
Community and Public Facilities and Public Open Spaces

The area reflects a high level of social need with health, education and safety thus key public services in the area (CoCT, 2011). Some places in the area are well serviced with a clustering of public services accessible in main centres while other areas especially those on the borders of Khayelitsha have access to some community and public facilities. There are a large number of schools in the area (Map 3.11) as well as around 10 clinics and a hospital making these accessible to most parts of the study area, with the aid of public transport for some parts. There are also some community facilities such as halls

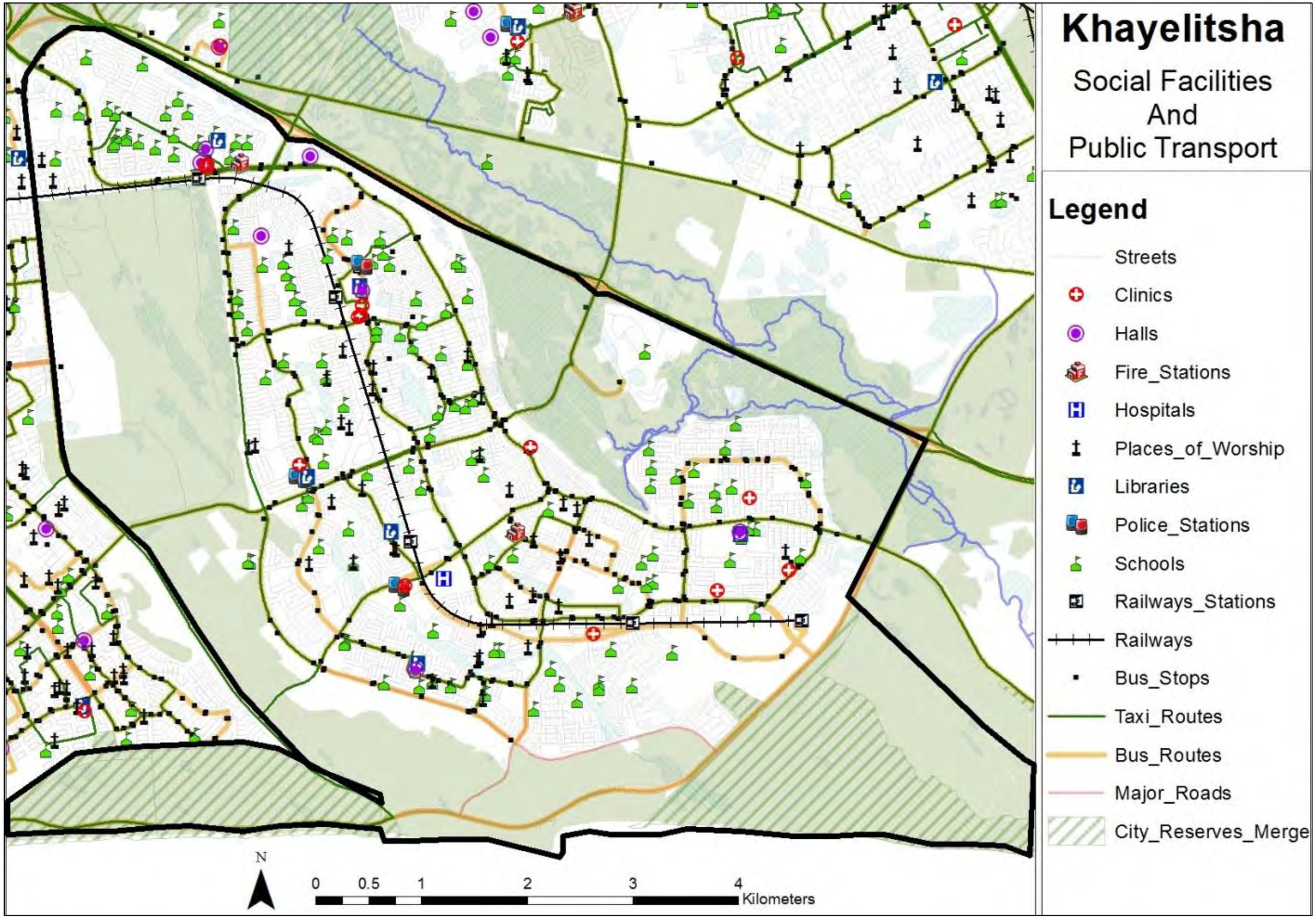
and libraries as well as public open spaces including recreation areas accessible to the public. However, most public spaces and streets are poorly developed which restricts the public engagement in recreational activities (CoCT, 2011).



Map 3.9: Current Land Use Types in Khayelitsha. (By Author. Source: CoCT GIS data 2013).



Map 3.10: Vacant Land Areas in Khayelitsha. (By Author. Source: CoCT GIS data 2013).



Map 3.11: Social Facilities and Public Transport Routes in Khayelitsha. (By Author. Source: CoCT GIS data 2013).

3.2.4 Services Delivery and Utilities

Climate change related extreme weather events presents threats to utilities and infrastructure leading to disruption in service delivery and costs of repairing damaged equipment and rebuilding infrastructure. Because access to basic services is important for human development, households with limited or no access to public services are usually more vulnerable to climate change. Public utilities such as drainage systems and sewerage systems are also prone extreme weather events resulting from climate change.

The study area is served by the Zandvliet sewage works which is currently operating to capacity and requiring upgrades with increasing demand. A local drainage system serves the area with channelling storm water flow from settlements into the Kuils river and the ocean thereby reducing the prevalence of floods.

Water and Sanitation

Water and sanitation is an important factor of climate change adaptation as it aids in reducing waterborne diseases as well as improve the living standards of people in an area. The majority of households in the study area are serviced with a few households especially in informal areas still without access to basic services. Most households have access to piped water inside dwelling (34.6%) while 27.3% of households have access to piped water inside their yards but outside their dwellings (CoCT, 2013). In terms of access to toilet facilities, 71.7% of households have access to flush toilet (connected to sewerage system) (CoCT, 2013). However, some basic service backlogs exist in the area especially in several informal settlements. 37.3% of households have no access in their yards and 0.8% of dwellings in the area have no access to piped water. About 6.6% of households in Khayelitsha use a bucket toilet while 10% of households have no access to a flush toilet facility.

Domestic Energy Consumption

Changes in temperature, precipitation, sea level, and the frequency and severity of extreme weather events will probably affect energy production and consumption (EPA, 2013) thus leading to changes in demand for energy for heating and cooking in households. Communities without access to electricity are likely to use alternative energy from fossil fuels such as paraffin which have negative health consequences and further add to air pollution. The area is predominantly connected to electricity with 80% of households using electricity for lighting (table 3.4) and 75% for cooking.

However, most households in Khayelitsha use paraffin for heating. There is a lack of alternative energy sources (such as solar and wind) in the area with a high dependence on electricity and fossil fuels. In line with a need to create resilience to climate change and with the growing cost of energy, alternative energy sources offer cleaner energy supply options that would add to reducing the human causes of climate change while preserving finite natural resources.

Khayelitsha Energy used for Lighting	Black African		Coloured		Asian		White		Other		Total	
	Num	%	Num	%	Num	%	Num	%	Num	%	Num	%
Electricity	94 692	80.7%	450	92.0%	48	76.2%	84	80.0%	756	94.0%	96 030	80.8%
Gas	417	0.4%	0	0.0%	0	0.0%	0	0.0%	3	0.4%	420	0.4%
Paraffin	17 298	14.7%	27	5.5%	12	19.0%	18	17.1%	27	3.4%	17 382	14.6%
Candles	4 434	3.8%	9	1.8%	0	0.0%	3	2.9%	12	1.5%	4 458	3.8%
Solar	228	0.2%	3	0.6%	3	4.8%	0	0.0%	6	0.7%	240	0.2%
None	285	0.2%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	285	0.2%
Total	117 354	100.0%	489	100.0%	63	100.0%	105	100.0%	804	100.0%	118 815	100.0%

Table 3.4: Energy Used For Lighting in Khayelitsha. (By CoCT, 2013. Source: Stats SA, 2011).

3.2.5 Policies and Plans

The City of Cape Town has undertaken extensive work on climate change adaptation. For instance, the Energy and Climate Action Plan was approved in 2010 to make the City of Cape Town's commitments operational and for the basis on which to prioritise, budget and implement the City's Climate Change and energy programme (CoCT, 2011). Coordinated by the City of Cape Town's Energy and Climate Change Unit, the action plan

outlined objectives including targets and implementation plans as well as projects to be implemented. However, the action plan focuses on the energy aspect of climate change, with a goal of creating a reduced city carbon footprint, energy efficiency and increased access to cheap and clean energy to Cape Town residents (CoCT, 2011).

Furthermore, although the City of Cape Town has initiated climate change adaptation plans, most work has been carried out in the environmental institutional sectors with limited integration into development and spatial planning institutions and frameworks (Taylor et.al., 2013). According to Taylor et.al. (2014) although significant progress has been made on assessing local climate risks and impacts, a major challenge has been embedding adaptation theoretical plans into municipal budgets and operations to initiate implementation. This limits success at local level of intervention in dealing with climate change where climate change is predominantly an environmental issue, thus mostly handled by environmental bodies at the national level of governance. Because in practice climate change continues to be addressed separate from economic growth and the provision of public services, “adaptation efforts tend not to feature as a systemic element of municipal planning and budgeting” (Taylor et.al., 2013, 66). This requires institutional changes to facilitate application of climate interventions on a local planning scale.

The separation of climate adaptation planning poses challenges for the City and its residents especially the vulnerable people in low income areas such as Khayelitsha. The poor and marginalized usually have the least buffer to face even small climate hazards, and suffer most from continual events with limited recovery time (IPCC, 2014). This is the case for example in the Cape Town Metro South East area where floods in winter and heat waves in summer occur annually. According to the IPCC (2014, 8), “Poverty and persistent inequality are the most salient of the conditions that shape climate related vulnerability”. For adaptation to work in these vulnerable areas, underlying socio-economic challenges have to be addressed. According to Füssel (2007) efficient adaptation requires consideration crucial factors influencing planning decision making,

for instance climatic risks, key non-climatic challenges, and economic development plans. Therefore, to effectively adapt to climate change, socio-economic challenges that increase vulnerability of communities to climate change have to be addressed. The next section outlines main socio-economic factors that will inform the local area plan for the study area.

3.2.5 Legislation

With increasing demand for land for residential developments and given the state of the critical biodiversity resources and water scarcity, there is a need for laws to protect remaining resources and guide future developments and exploitation of resources. In South Africa, national government has the supreme power and thus is responsible for the major decisions that drive the direction and agendas of the provinces and municipalities under them. Key legislations that will inform the adaptation interventions proposed in chapter 4 will be discussed in the implementation (chapter 5).

3.2.6 Key Climate Adaptation Issues

This section draws from the environmental and socio-economic analysis to identify main issues to be addressed in an attempt to increase the area's resilience to climate change. These issues will be used to guide the formation of strategies that will inform the local area climate change adaptation plan in this dissertation. 5 key issues are identified and these are: natural resource management, human development, economic development, disaster management, increased public engagement in adaptation planning.

The study area holds some important and valuable natural resources in the city. With its rare biodiversity assets and identified as a potential water source, there is a need for natural resource management to protect these crucial resources from human land uses and urban growth. These resources have the potential to aid the area against future changes in climate conditions and predicted severe weather events.

Secondly, vulnerability to climate change is linked to human development. Places that are still underdeveloped such as most countries in the global south are most vulnerable

to will likely be severely affected by changing climate conditions. Therefore, there is need to address social ills when creating adaptation plans. Furthermore, social Justice and Inclusion is important for development and thus should be included in all development goals and plans. Development plans should promote equality and social wellbeing and ensure that basic services and social facilities are accessible to all households.

In addition to social justice, there should be economic development in the study area to create opportunities for people and reduce unemployment and inequality thereby reducing poverty. This would potentially reduce the amount of money spent in welfare programmes thereby adding to the financial resources of the country. Financial stability would also increase the buying power of people allowing them to build stronger houses that can withstand the impacts of climate change as well as afford to rebuild after a natural disaster.

Land is a valuable resource that is at the heart of development efforts of an area. With the growing urban population in the study area, the demand for land will increase in the future further increasing the threats of human land use on natural systems. To this end, future land uses have to be managed to promote sustainability and resilience to climate change. Resilience to climate change would be promoted through decisions about the future location of settlements in less disaster prone places. With the growing challenges resulting from climate change, future land use applications should include a strategy that promotes the area's resilience to climate change.

Lastly, because climate change adaptation actions at a local area scale will mainly affect local residents, increased public participation in adaptation planning will ensure that their voices, ideas and concerns are considered which. Public participation refers to "securing active involvement of a broad range of stakeholders in decision-making and action" (Few, 2006: 2). This also helps in gathering information about the local area problems resulting from climate change to effectively design actions that are relevant to the local context. However, public engagement also includes education and training of

stakeholders about climate change to as well as creating public awareness about climate change.

3.2.7 Conclusion

Actions for adaptation to climate change should be aligned with the context of the area the adaptation plan is intended for. This ensures that the plan is well informed and relevant for the area. This chapter has outlined an environmental and socio-economic analysis, highlighting key issues for intervention in the area and informants that will guide the climate change local area adaptation plan in this dissertation. The next chapter presents the climate change local area adaptation plan for Khayelitsha.

CHAPTER 4 INTERVENTION: LOCAL AREA CLIMATE CHANGE ADAPTATION PLAN FOR KHAYELITSHA

4 INTRODUCTION

Forward planning begins with an understanding of the status quo of an area, its underlying environmental, socio-economic and institutional factors informing development. However, with urban growth, development pressures increase requiring strategic use of limited resources to secure future growth of cities. Forward planning enables decision makers in cities to guide and manage resources to achieve optimal future outcomes for their inhabitants.

The overall intention of this local area adaptation plan is to direct and manage future settlement growth through a development path that is geared toward promoting climate resilience and sustainable growth. The proposed development plans would adapt Khayelitsha to future climate change while enhancing the quality of life and increasing the longevity of natural assets. However, with future uncertainties, this adaptation plan is intended to be flexible and comprise of short term (5 year) to medium term plans and strategies. Proposed strategies will have to be reviewed based on the local trends to ensure that they remain relevant to the local area. This chapter presents local area interventions aimed at increasing climate change resilience of Khayelitsha.

4.1 Vision for Khayelitsha

The development vision of the Khayelitsha area is based on an idea of structural resilience envisioned for the area. The vision is informed by inherent socio-economic challenges outlined in chapter 3 that contribute to climate vulnerability in the area. Whereas the development vision represents spatial outcomes envisioned for

Khayelitsha, it is intended to represent metropolitan-wide areas with similar characteristics and climate vulnerabilities as Khayelitsha.

4.1.1 Vision statement

Khayelitsha is imagined as a place where residents can live in harmony with equal opportunities accessible to all. It is a place where residents value and strive to protect their natural assets and local settlements complement existing natural areas with sustainable urban growth at the centre of all development activities. Through spatial planning and urban development interventions with that consider and incorporate climate change, settlements and infrastructure in Khayelitsha would be developed to withstand the threats and impacts of climate change, while efficiently using resources to enhance the quality of life for all. In addition, residents would exploit opportunities brought by visitors (tourists) to create economic opportunities by establishing small scale businesses.

The vision for Khayelitsha is that it develops into a self-sufficient suburb where residents live with minimum dependency on other areas for services and resources such as energy, water, sanitation and also creates opportunities for human growth within the area. High living standards are promoted by efficient service delivery and public facilities accessible to all. In addition to standards of living, sense of place is promoted by public open spaces and walkable streets that complement local area landmarks. Finally, local residents inform most decisions through public participation processes managed by city council officials.

4.2 Values/principles

These values are based on the desire to promote social and economic growth with minimum harm to the environment. Based on the vision of this adaptation plan above, a set of values or guiding principles are laid out in this section.

Environmental Integrity

In light of limited resources, future urban growth and development should not occur in the expense of the natural environment. With the current rate of consumption, the capacity of the earth to sustain life diminishes. This calls for interventions that would enhance and protect natural assets to improve environmental quality.

Access

With the growing population, scarcity of resources and lack of opportunities for human development in the area, residents are increasingly affected by poverty. Therefore, access to facilities and services would add to human development and wellbeing of residents of Khayelitsha.

Integration

The separation of climate actions from planning actions creates fragmentation and inefficiency in promoting resilience to climate change. Integration of these plans would promote more informed development paths that ensure that future climate change impacts have minimum impacts to human settlements.

Efficiency

The delivery of services is currently unsatisfactory, manifested by backlogs and inequalities in access to services. Also, minimum collaboration between different stakeholders involved with making decisions that affect communities, results to inefficiency. Therefore, to achieve successful sustainable development and adaptation to climate change, efficiency should be improved.

Safety and Security

The location of people in high risk areas without proper infrastructure provisions increases vulnerability to natural hazards. Therefore, planning interventions should work toward improving resilience for people.

4.3 Objectives

"Projects and programmes have a greater chance of success when the objectives and scope of the programmes or projects are properly defined and clarified" (UNDP, 2009:

7). Outlining clear objectives also increases the chances of success in the implementation of initiatives. The purpose of this local area adaptation plan is to put forward a set of interventions for adaptation to climate change in Khayelitsha. To achieve this purpose, the following objectives are set out:

- To promote sustainable development through the management and protection of natural assets. This means creating opportunities for settlement growth that improves people's standards of living without compromising natural assets. Due to the destructive nature of human land uses on natural assets, this adaptation plan proposes actions that will protect and enhance the quality of natural assets. This is from recognition of the potential of natural assets to create buffers to climate impacts and also provide ecosystems services and life support to the local community.
- In light of the expected future impacts of climate change, this adaptation plan lays out plans for reducing climate vulnerability in Khayelitsha, creating readiness to respond to and resilience to future changes in climate conditions.
- This adaptation plan also aims to integrate climate change response actions into development plans creating unified future development strategies. These strategies aim to reduce vulnerability to climate change through improving access to social services and economic opportunities, while reducing physical causes of climate risks in the area.

4.4 Conceptual Development Framework

As highlighted in the context analysis in chapter 3, there are existing (spatial and non-spatial) socio-economic and environmental issues that would increase vulnerabilities to climate change in Khayelitsha. Key development priorities based on the context findings form the basis for this theoretical development framework. In this section, spatial concepts for each development priority are outlined and will inform the local area adaptation plan where spatial interventions are proposed. These interventions aim to guide future development of Khayelitsha into an area resilient to climate events and with opportunities that increase the quality of life for all residents.

4.4.1 Development Priority 1 – Natural Systems

Natural systems play an important role of supporting life by providing primary commodities required to sustain human systems. Also, with the changing climate conditions expected to increase future natural threats, natural systems provide buffers that reduce the impacts of climate change on human settlements. However, human settlements have evidently threatened and continue to pose threats to natural areas interrupting the functioning of natural systems resulting to a realisation of a need to conserve remaining natural assets. Thus the first development priority for Khayelitsha is to increase environmental management activities that seek to protect remaining natural assets from human land uses in Khayelitsha.

Furthermore, a public open space system in Khayelitsha is important for conserving some biodiversity resources and for adding to flood preservation through adding water catchment functions. In addition, public open spaces would add to the sense of the area as well as provide recreational facilities in Khayelitsha. The aim is to maintain existing open space systems and green corridors in Khayelitsha forming part of the metropolitan green network.

4.4.2 Development Priority 2 – Services and Opportunities

Findings from the contextual analysis in chapter 3 show existing negative socio-economic and settlement trends in Khayelitsha, with challenges that undermine the well-being of residents and human development efforts. In light of projected climate change impacts, these socio-economic and settlement trends increase local susceptibility to climate change. To this end, strategic social development interventions are required to enhance people's standards of living and improve resilience to climate change.

For human development to be achieved in the area there should be adequate access to services and infrastructure provisions to improve efficiency in delivering services to households. In addition to access to services, economic opportunities should be created through public and private investments that promote economic development in the

area. The following obligations pertaining to access to access to services and economic opportunities are stipulated:

- Nodal developments would be integrated with a transport system that incorporates different modes of transport including non-motorised transport.
- Services would be clustered in major nodes that are characterised by mixed land uses with high densities to maximised agglomeration of facilities.
- Facilities for informal economic activities should be provided to enhance the quality of the informal economic sector as well as products and services offered.

4.4.3 Development Priority 3 – Resilience and Risk Management

Khayelitsha experiences natural disasters such as floods (that occur annually) and fires. These result to damage of property and sometimes lead to loss of life. With the projected climate changes in the area and surrounding areas and given the poor location of some settlements especially informal settlements, the frequency of those weather related events will increase, causing further damage to infrastructure and property as well as increasing threats to human life. In order to adapt to climate change, future development interventions should include risk management strategies aimed at increasing resilience of settlements to climate change. The following areas pertaining to promoting resilience and managing climate risks are outlined:

- Future structures should be developed ready to withstand weather related events with the focus on housing and utility infrastructures in the area to build resilience to climate change.
- Land use regulations should include provisions for preventing the formation of settlements in high risk areas such as catchment areas and wetlands to ensure that households are located in settlement development appropriate areas.
- Work toward developing and evacuation plan that includes temporary accommodation for people affected by weather related events. Also invest in eradicating informal settlements and solve current housing problems and backlogs.

4.5 Key Strategies: Main Spatial and Conceptual Ideas

4.5.1 Protect and Manage Natural Resources

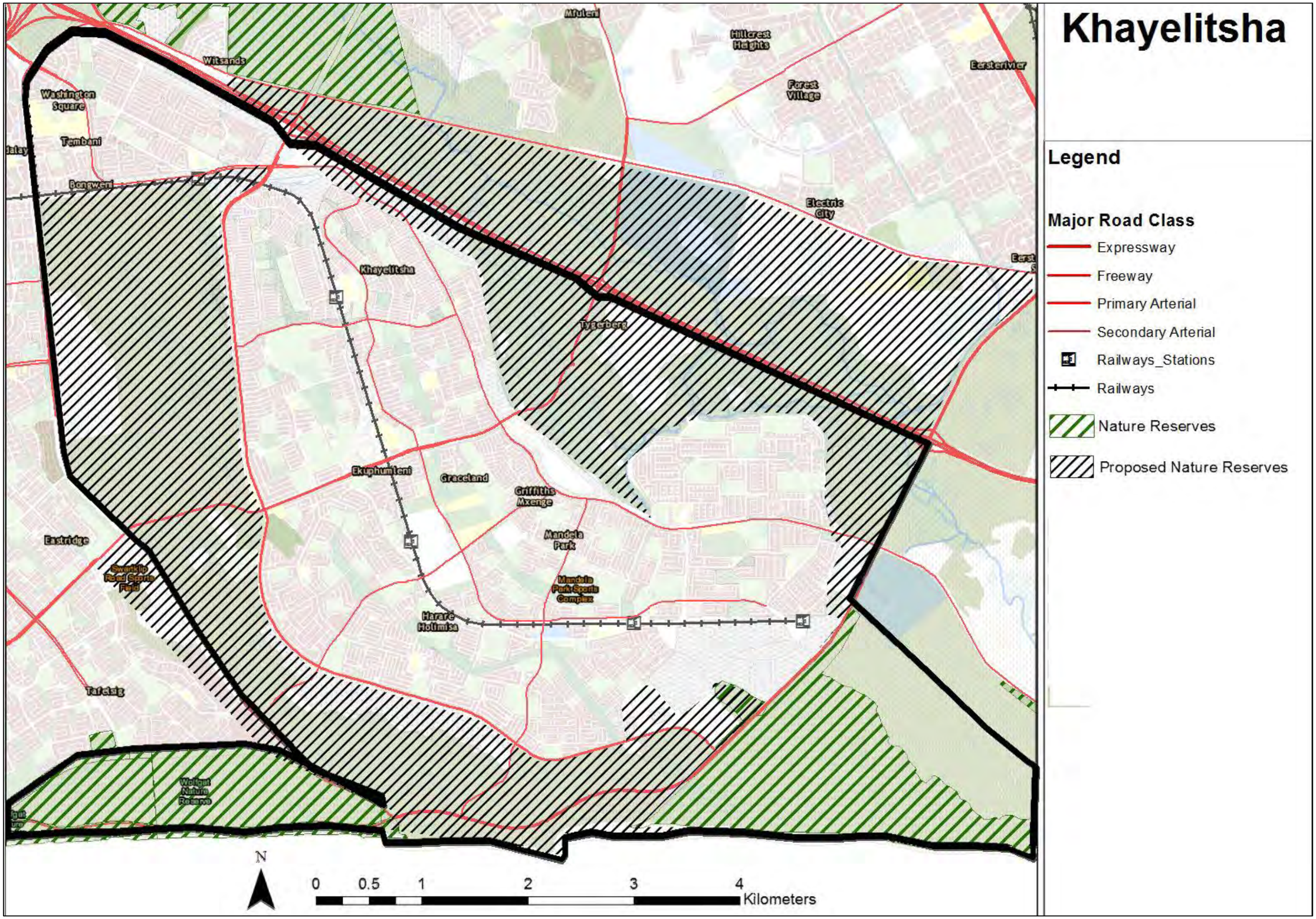
a) Natural Resource Protection Actions:

This report proposes the extension of city reserves to include areas that are currently identified by the City as areas of National biodiversity significance. Protecting areas of natural assets contributes towards retaining and conserving biodiversity (CoCT, 2014). The City of Cape Town established and manages 16 nature reserves within its borders.

Proposed Actions:

- ***Extension of nature reserves and the wetlands park***

  Increase biodiversity areas into City reserves through the extension of the City of Cape Town Reserves in the Khayelitsha area (Wolfgat and Driftsands Nature Reserves) as well as extend the Khayelitsha Wetlands Park to increase the area of wetlands area that will fall into the park's boundary. Fence boundaries are proposed that would separate settlements from areas of critical biodiversity, wetlands and sand dunes Map 4.1. It is hoped that the fence would create a boundary that would potentially prevent the spread of settlements (mainly the extension of informal dwellings as highlighted in chapter 3) into areas of significant natural assets.



Map 4.1: Proposed Extension of Nature Reserves. **(By Author. Source: CoCT GIS data 2013).**

- ***Enforcement of protection regulations***

  However, for the proposed protection measures to work, this report proposes policing and monitoring of protected nature reserves and parks to enforce the proposed protection regulations. A law enforcement branch would be established in Khayelitsha to enforce protection regulations in the area and act against infringement of natural resource protection regulations. In addition to protection, there are management of remaining resources to maintain and improve the quality of natural assets and proposed management actions are outlined below.

b) Natural Resource Management Actions:

Natural systems rehabilitation programs can improve the quality of natural assets that have been affected and are threatened by human land uses. To this end, improving the state of natural systems should be included in the adaptation process. Natural ecosystems have the potential to provide some critical services for instance, well-functioning natural habitats on coasts or in floodplains can protect against extreme weather events (European Commission, 2013). Therefore, there is need to ensure that the state of natural resources in the Khayelitsha area is improved to improve the functioning of natural ecosystems.

Proposed Actions:

- ***Wetlands and River cleaning***

  Wetlands and rivers in the area are affected by human land uses resulting to pollution of water reducing the quality of water in other catchment areas. Cleaning of water systems is proposed which would improve the quality of water resources, thus adding to future water availability.

- ***River bank management***

  Decanalise the river and create riparian buffer zones to reduce the likelihood of floods while reducing soil erosion along river banks and wetland areas.

- ***Removal of invasive plant species***

Invasive plant species pose threats to biodiversity in the area. These plants also consume large quantities of water resulting to reduced water resources for indigenous plants in the area.

- ***Local Natural Resource Management Department***

  Establish a local office (as part of the City of Cape Town) to administer management actions. This would reduce the time for proposals to be implemented and also create an opportunity for frequent monitoring and management of natural resources in the area. The department would also be responsible for education and informing local residents about the importance of natural resources in the area with the aim of increasing support and cooperation from residents. Local residents would also use the local office to report incidences of breach of regulations which would allow for speedy responses to these breaches.

4.5.2 Promote Socio-Economic Development

a) Social Development Actions

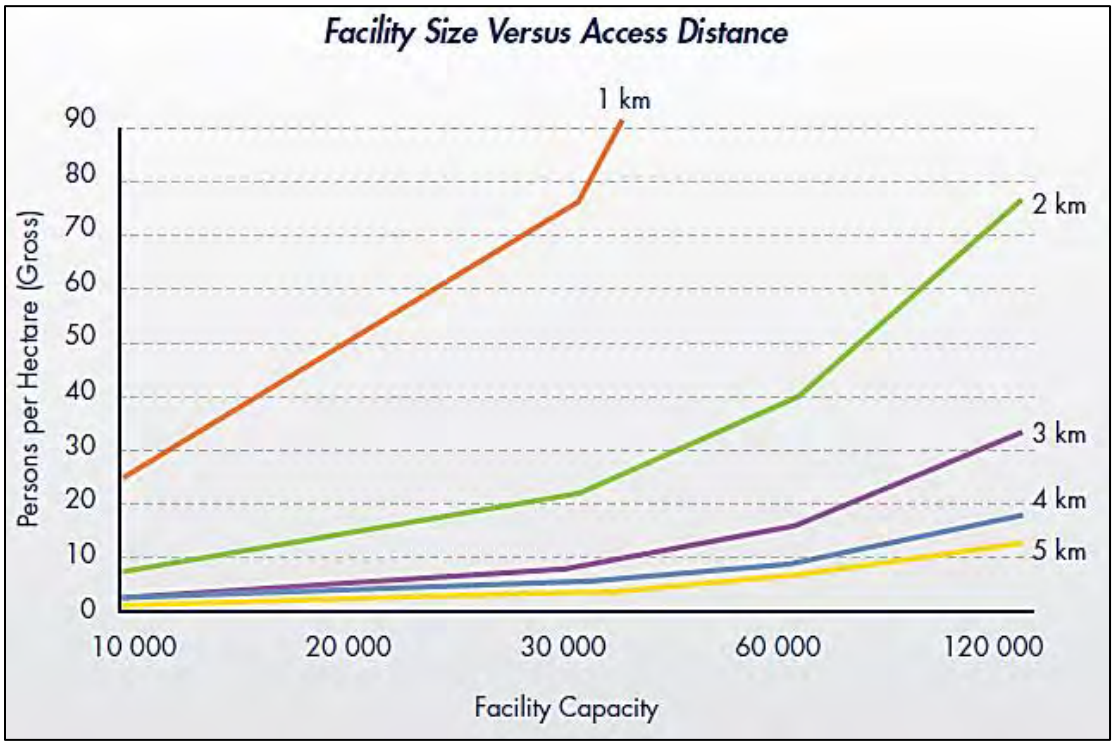
Proposed social development strategies will lead to an increase in access and choices of services for residents. This would add to the human development of residents while contributing to poverty reduction and also compliant with the national strategy for social development as well as meeting the rights stipulated in the Constitution of the Republic of South Africa.

Proposed Actions:

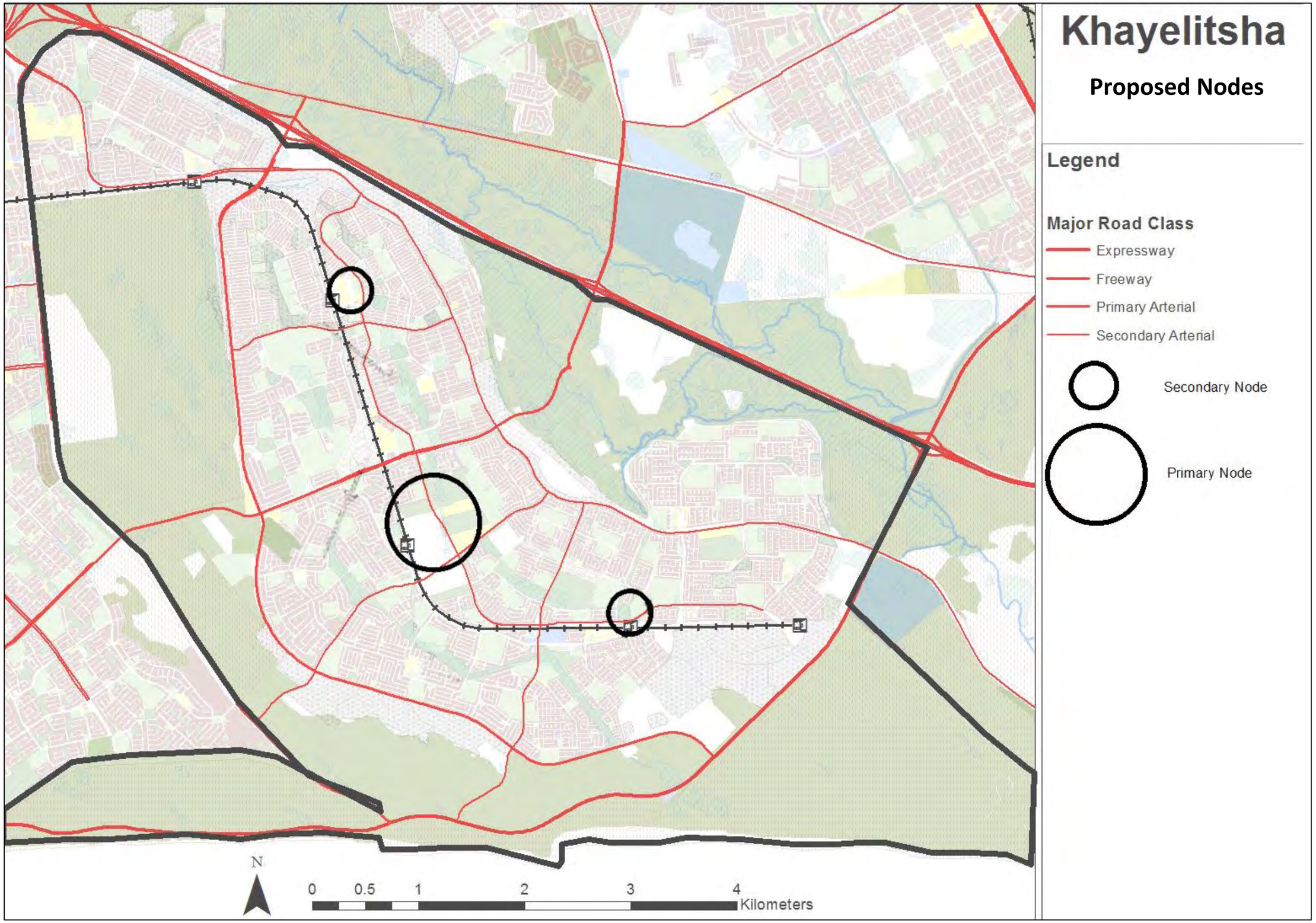
- ***Clustering of social services***

  This report proposes the provision of mixed services in a combined cluster of social and public facilities. As a result of limited vacant land in the area, clustering services (for instance schools, health care facilities, libraries and sports fields) would lead to increased services on a small land area thereby saving space. This strategy would result to various facilities located in central areas or major nodes (refer to proposed nodes in Map 4.2) of Khayelitsha sharing space to create more space for housing and other future developments. The establishment of these nodes will be based on Transit Oriented

Development that directs future development along transit facilities. The proposal of nodes will integrate movement systems and settlement densities to achieve increased agglomeration of facilities serving a larger group of people. Facilities provided for service provision will be calculated based on the population thresholds (minimum number of people required for facilities to be established) and the distance from nodes in the area, in other words, the densely populated areas will have high capacity facilities in close proximity than the least populated areas (as illustrated in graph 4.1).



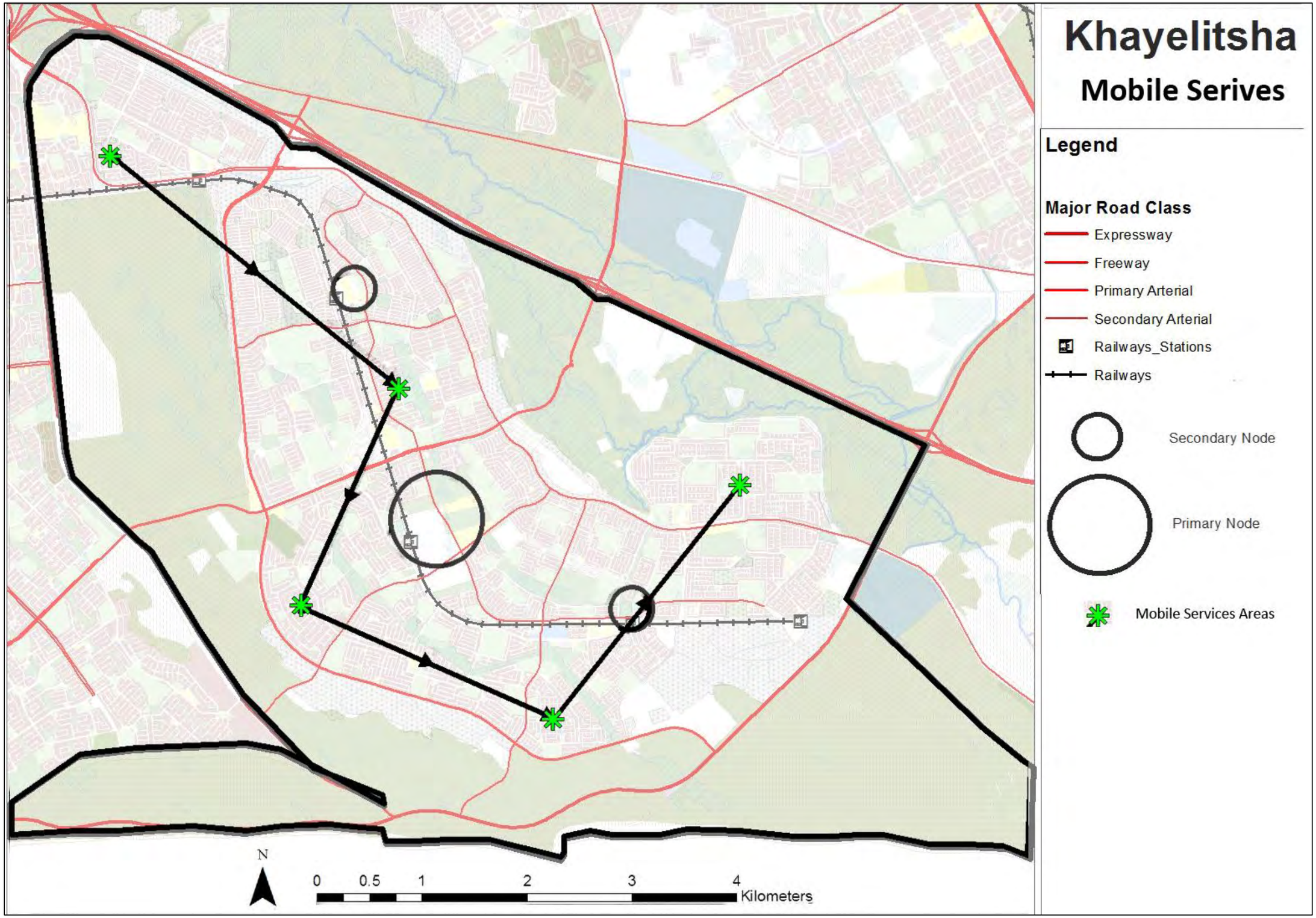
Graph 4.1: Facility size and distance parameters for various densities for application public facilities. (Source: http://www.csir.co.za/Built_environment/pdfs/CSIR_Guidelines.pdf).



Map 4.2: Proposed Nodes in Khayelitsha. **(By Author. Source: CoCT GIS data 2013).**

- ***Establishment of periodic and mobile services***

  To increase access to services in areas on the outer parts of the study area, mobile services are proposed. Mobile services are periodic service provision facilities that will rotate around the bordering parts of Khayelitsha (map 4.3) according to the demand for services based on the population densities. These facilities will rotate in a scheduled periodic manner during the days of the week. The services provided would also include government and information services that will make the services available in Khayelitsha instead of residents travelling to the Cape Town CBD to access these services. For example, there is a Thusong Service Centre branch in Khayelitsha that seeks to deliver government services to local residents. In 1999, the National Government of South Africa initiated the Thusong Service Centre programme to address historical socio-economic factors that limited access to services and information by citizens resulting to citizens travelling long distances to access these services (GCIS, 2014).



Map 4.3: Proposed Mobile Services in Khayelitsha. **(By Author. Source: CoCT GIS data 2013).**

- ***Increase community support services***

  This report proposes and increase to access to information about available opportunities such as available funding to promote education registration, especially at tertiary level which most learners do not reach. It is hoped that the additional support in form of information and funding would reduce the number of dropouts from school and thus increase levels of education in Khayelisha. This would increase the number of qualified people who would be employable, especially in the service sector and reduce levels of unemployment in the area.

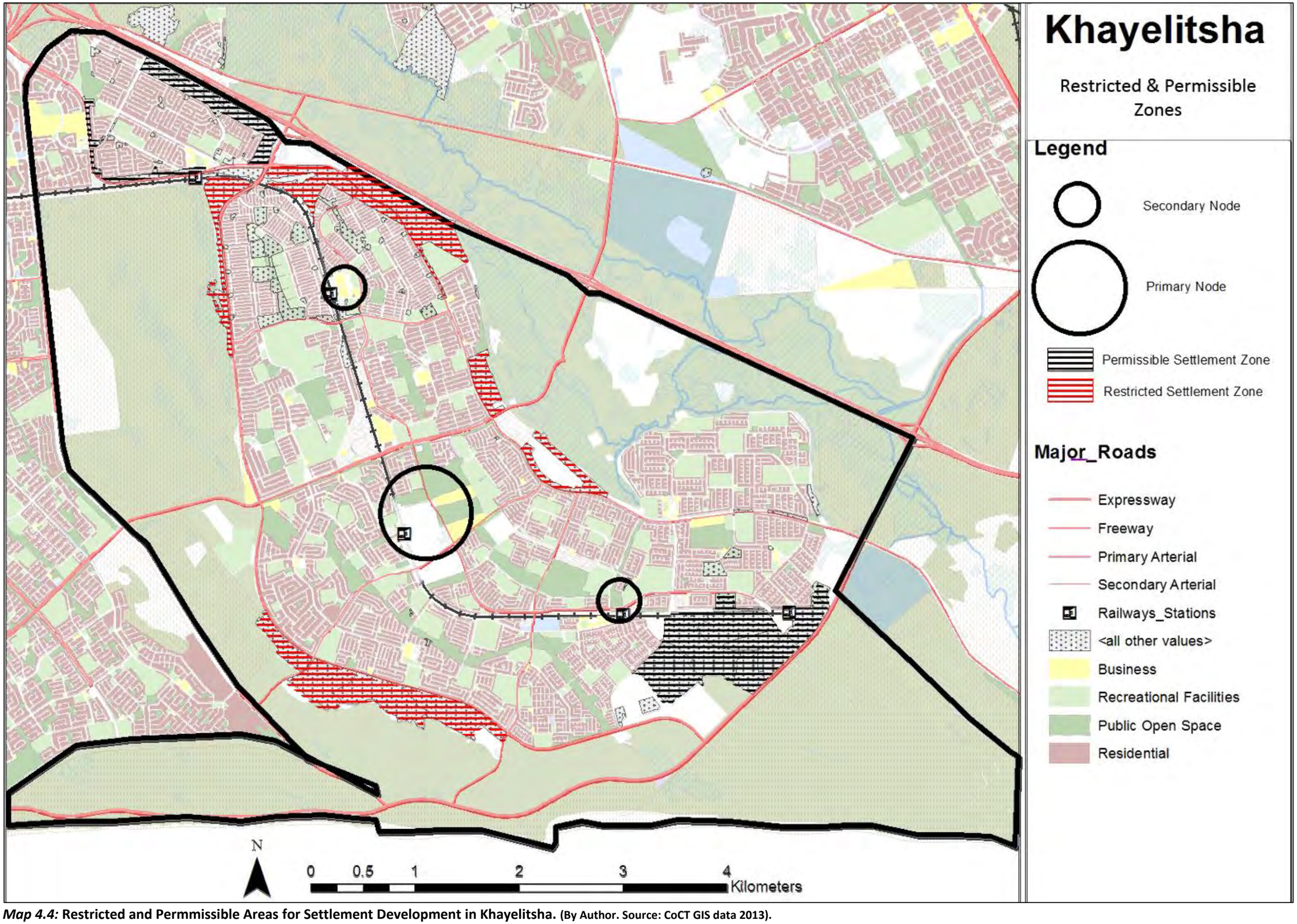
- ***Housing provision plan***

  As stated in chapter 3, Khayelitsha faces housing backlogs manifested by persistent growth of informal dwellings in the area. These informal settlements are usually located in risky areas that are prone to impacts of climate change making the residents highly vulnerable. Therefore, formal housing structures in appropriate and low risk areas would reduce the vulnerabilities to climate change in the area. Permissible settlement zones (where informal upgrading would occur) and restricted settlement zones (settlements where occupants will be relocated) are proposed (Map 4.4).

  This report proposes social housing developments to tackle existing housing backlog in Khayelitsha through informal upgrading. Social housing typologies characterized by elevated 2 story and 3 story low cost residential blocks of flats are proposed. This would further increase densities as a household would occupy rooms vertically instead of horizontally which would save space. There are currently informal upgrading projects that exist in Khayelitsha (such as the City of Cape Town Urban Renewal Programme, Violence Prevention through Urban Upgrading and various Non-Governmental Organisations such as Ikhayalami) that are working towards upgrading informal dwellings and creating liveable dwellings for residents of Khayelitsha.

  To adapt to future climate change, housing structures should be built and ready for climate change. This report proposes that future dwellings should be built to withstand the impacts of climate change thus reducing vulnerabilities to climate change for residents of Khayelitsha. Furthermore, current dwellings should be retrofitted (modified

to be well prepared for changing climate conditions) to increase current dwellings capacity to withstand the impacts of climate change. Retrofitting would also reduce the demand and use of energy in Khayelitsha dwellings. By retrofitting and building new houses to withstand climate change, energy required for warming in winter and cooling in summer will be reduced (Cavan and Aylen, 2012).



Map 4.4: **Restricted and Permmissible Areas for Settlement Development in Khayelitsha.** **(By Author. Source: CoCT GIS data 2013).**

- ***Provide infrastructure and utilities***

  Physical Infrastructure will be affected by climate change resulting to disruptions to the delivery of services (such as water and sanitation) which would affect local residents. Physical structures are also susceptible to climate related extreme weather events and rebuilding infrastructure damaged by extreme weather events is costly to the local municipality. Although investing in infrastructure upgrades is costly at present, it is seen to have high rewards in the future. Current uncertainties in relation to future climate change discourage investments in infrastructure upgrades because of unknown return on investment and unknown severity of future climate threats on infrastructure (European Commission, 2013).

  Therefore, this report proposes upgrades to infrastructures that are currently functioning over capacity. This would ensure that future changes (climate change, demands resulting from increased population size) are considered ahead of time when designing and installing physical infrastructures.

b) Economic Development Actions

Economic development is important for adapting communities to climate change. This is because a lack of economic opportunities would lead to an increase in poverty which increases vulnerability to climate change. High population densities in Khayelitsha present opportunities for businesses especially the retail sector. However, social context issues such as crime and low education levels hinder investments and businesses moving into Khayelitsha. As a result, most opportunities for residents of Khayelitsha are in other parts of Cape Town, resulting to travel (mostly long distances) of workers to places of work. Therefore, developing the local economy of Khayelitsha would increase work opportunities in the area which would add to an increase in people's standards of living thus potentially reducing vulnerabilities to climate change.

Proposed Actions:

- ***Support the informal economy***

  Currently, informal activity is limited by factors such as lack of space reserved for informal trade in places of high activity and most local businesses are located in neighborhood areas that are not accessible to areas of high movement of people (CoCT, 2011). Develop support facilities for informal businesses such as stands or stalls in activity routes. This would include storage facilities, roofed stall, and public sanitary facilities to support informal business activities in Khayelitsha. To this end, it is hoped that the quality of informal businesses would be improved and encourage more people to establish small informal businesses.

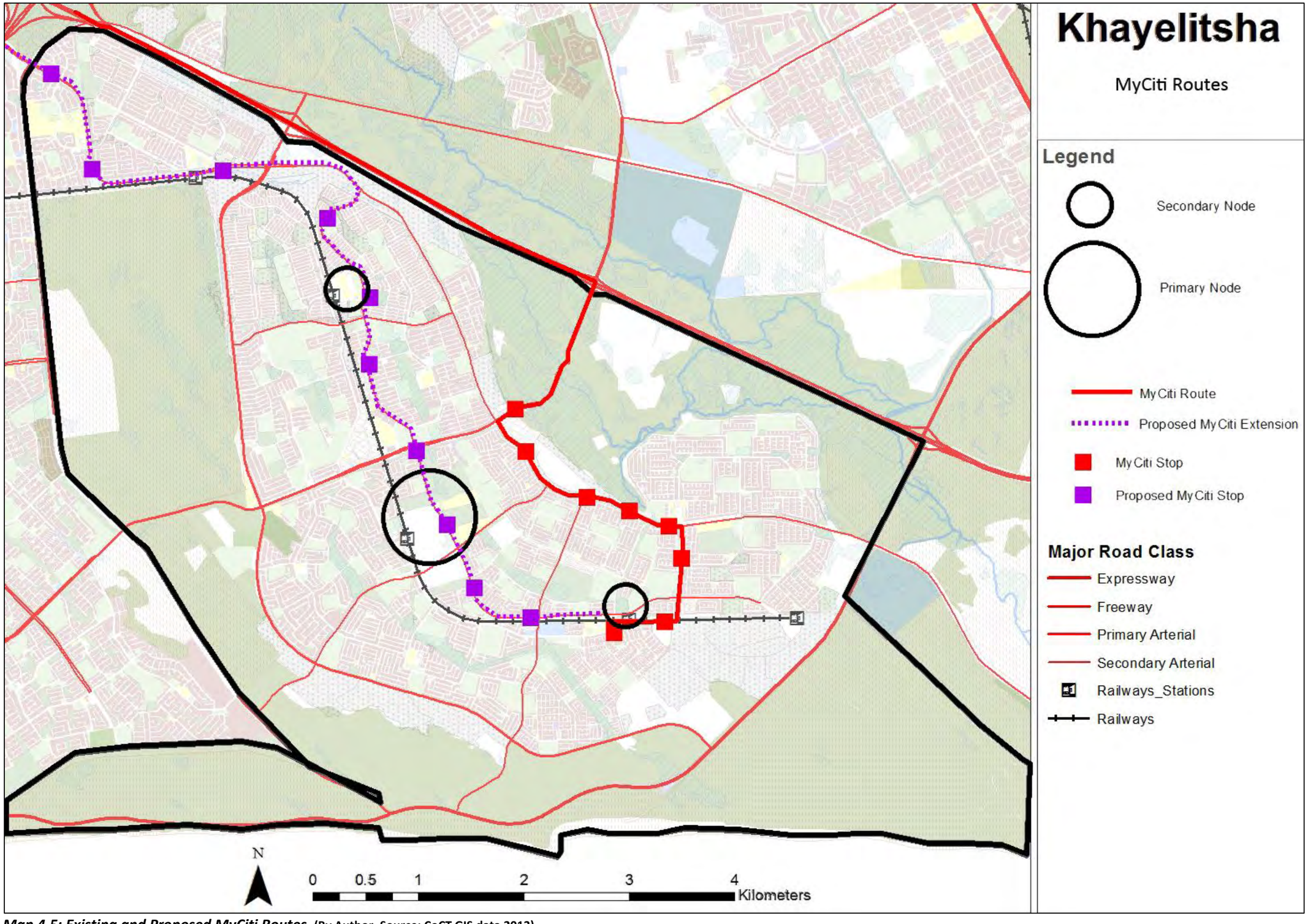
- ***Establish the green economic sector***

  With the unique biodiversity assets in the area, there is need for economic activities that are based on natural assets. This report proposes the promotion of ecotourism to generate jobs and increase the number of tourists visiting Khayelitsha. Ecotourism is defined as travel that promotes the conservation of natural assets and adds to improving the well-being of local people (TIES, 2014). This form of tourism is appropriate in Khayelitsha where most natural assets are threatened by urban development as it would increase the perceptions of value of natural assets to local residents, thus increase residents buy-in in conserving natural areas. In addition to ecotourism, the Khayelitsha area already receives some tourists for township tourism activities. To facilitate tourism in the area through creating walkable streets and promoting safer non-motorised transport supported by an efficient public transport system.

  Climate change is likely to increase energy demand putting pressure on the country's energy reserves. Therefore, alternative sources of energy would reduce the dependence on national energy. The report proposes green energy production in the area specifically biogas production. Biogas can be produced from household waste which is fermented in the absence of oxygen to produce biogas.

- ***Improve transport system***

  The City of Cape Town rolled out the phase of the MyCiti IRT system that services the Khayelitsha and Mitchells Plain area. However, the route only goes around the area and enters the Khayelitsha area through the south east towards Kuyasa station where it makes a U-turn back toward the Cape Town CBD (Map 4.5). A route that goes through the middle of the Khayelitsha along Ntlazane road is proposed as seen in map 4.5. This would make the MyCiti service accessible to a larger area of Khayelitsha. The proposed route would also link the MyCiti service to proposed nodes and the existing rail stations (Khayelitsha station to the south and Nonqubela station to the north). However, transport infrastructure development and improvement is proposed to enhance the quality of the existing public transport system.



Map 4.5: Existing and Proposed MyCiti Routes. **(By Author. Source: CoCT GIS data 2013).**

- ***Other infrastructures to support economic development***

  Provide supporting infrastructure that would enable efficiency of business services and support business processes in the area. To this end, a creation of business opportunities in Khayelitsha would attract investors to further establish businesses in the area thus adding to economic development and job creation. In addition to transport systems (road and rail), infrastructures such as telecommunications, rental buildings for office and retail as well as warehousing space would be made provided and available for businesses to occupy.

  The Khayelitsha area has the highest crime rates than any other suburb in Cape Town (CSPRI, 2012). High crime rates can discourage investors from investing in an area (Detotto and Otranto, 2010), with investment choices often favouring areas with low crime levels. Therefore, the high rates of crime in Khayelitsha discourage investment in the area resulting to slow economic growth and low number of business investments in the area. Furthermore, the context findings from chapter 3 in this report show that the majority of people in Khayelitsha do not have matric (and above) education qualifications. This would also potentially discourage investors into the area as there would be a shortage of skills required by companies compared to other parts of Cape Town. The report proposes the provision of services aimed at reducing social issues such as crime and low levels of education) that can hinder investment and economic growth in the area.

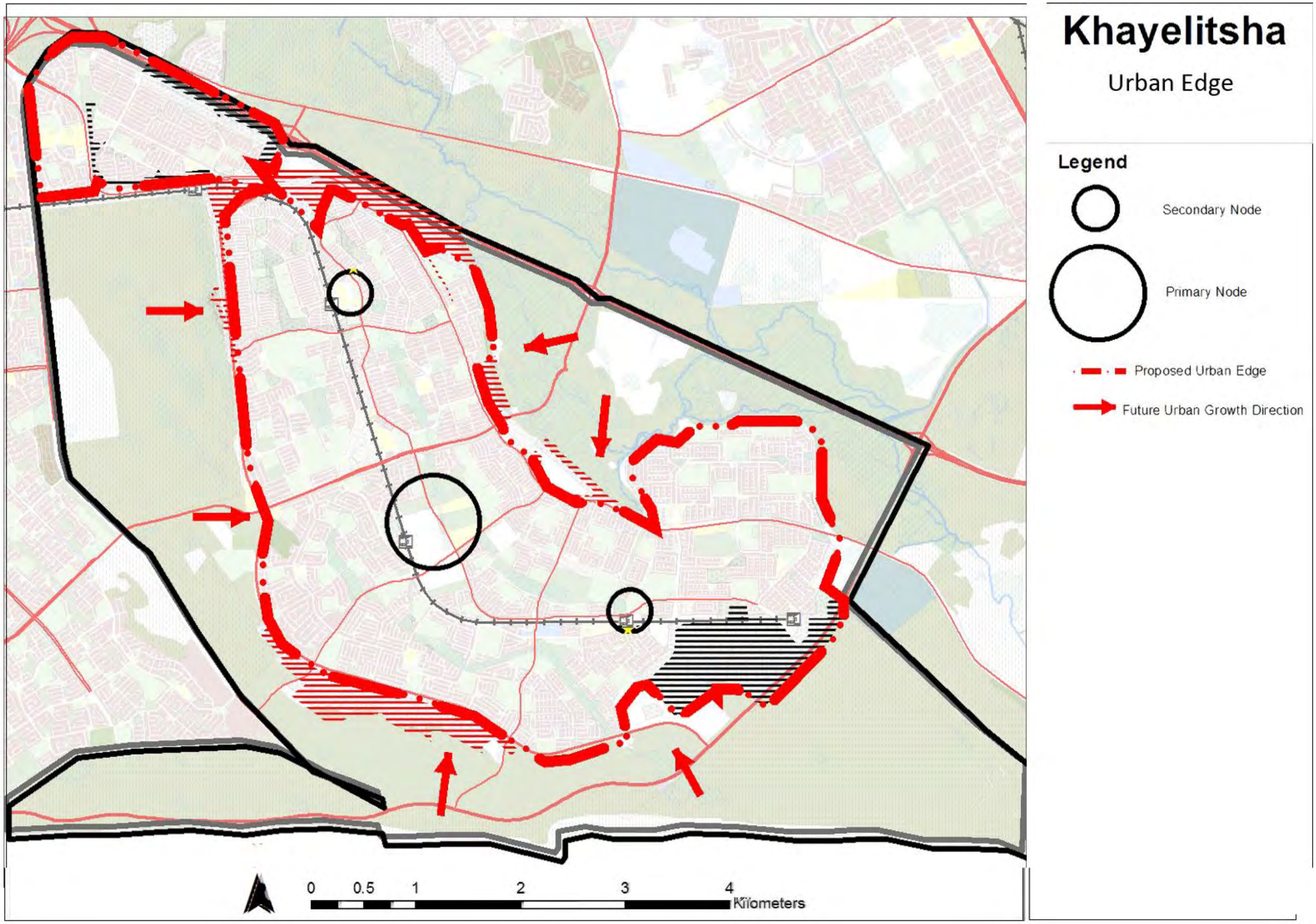
4.5.3 Protect People and Assets in Vulnerable Areas

Spatial planning seeks to plan for manage the use of land to ensure that land uses are appropriate, have minimum harm to natural systems and enhance people's lives. This means promoting safety to residents, their property and public infrastructure. The proposed strategies seek to prevent risks and reduce chances of occurrence of events that would threaten resident's lives and property.

a) Urban Edge and Settlements Relocation

- ***Redefine the Urban Edge***

Most informal dwellings in the area are established in risk prone areas such as flood plains and wetlands where residents become vulnerable from natural disasters as well as threaten natural areas in those areas. Urban sprawl has resulted to an increase in these informal settlements on mostly on the outskirts of Khayelitsha. These settlements are characterised by informal dwellings that are usually affected to weather related events such as floods (occurring annually during every rainy season) as well as fires. This report proposes an urban edge (Map 4.6) that will prevent the spread and location of settlements in hazardous areas in Khayelitsha. This urban edge will be supported by a fence that form part of the nature reserves boundaries. This would reduce access to wetlands and the Kuils River for surrounding settlements.



Map4.6: Proposed Urban Edge in Khayelitsha. **(By Author. Source: CoCT GIS data 2013).**

- ***Relocate People in Vulnerable Areas***

  Given that a significant number of settlements in Khayelitsha are located in risk prone areas (such as wetlands and close to the river); residents in these settlements will be increasingly affected by weather related events. This calls for creating developable land within Khayelitsha or identification of vacant land in other parts of the City for settlement development where people will be relocated to.

b) Reduce Risks Associated with Water

- ***Flood prevention***

  As shown in chapter 3, flood events already occur in Khayelitsha affecting residents especially in informal settlements. Future climate predictions in the area show an increase in the amount and frequency of rainfall. This will result to an increase in flood events especially in the rainy winter season. This report proposes an improvement of the current storm water drainage system to channel water away from settlements and reduce likelihood of floods.

  Development of riparian buffer zones is proposed along the Kuils riverbanks (figure 4.1) and around wetlands to aid in the reduction of flood events and reduce erosion of the river banks. This intervention will be supported by relocation of people from flood plains to areas appropriate for settlement development. The riparian buffer zone will form part of the protected area included in the extended reserve. A riparian buffer zone is vegetated land beside the river banks that interacts with runoff when it overflows into the floodplains (Parkyn, 2004).

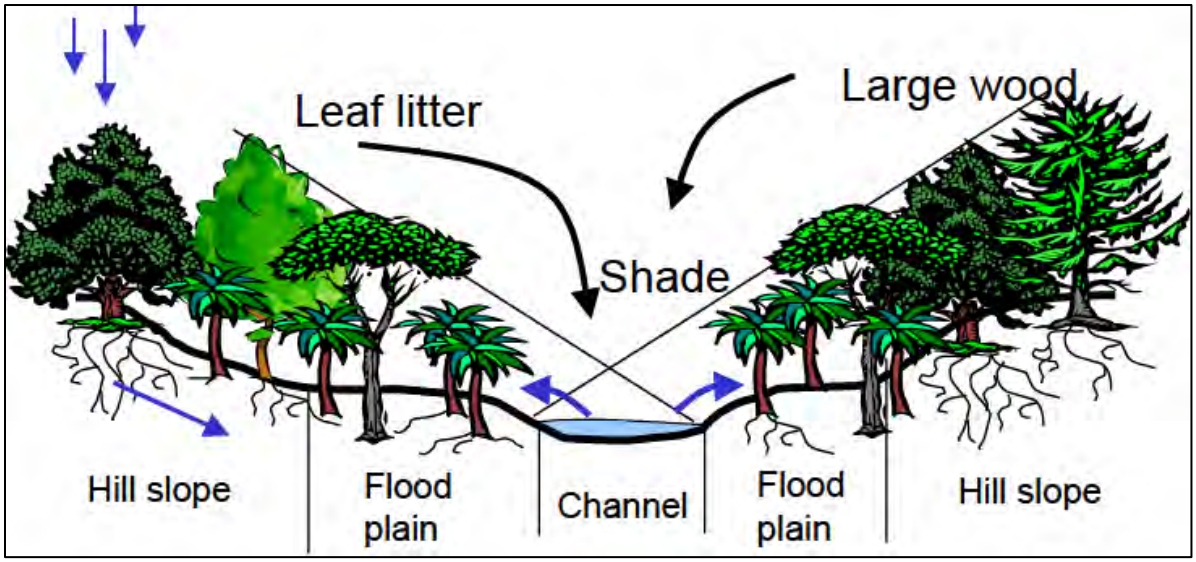


Figure 4.1. Diagram Showing a Vegetated Riparian Buffer Zone. (Parkyn, 2004).

In addition to riparian buffer zones, maintaining the coastal buffer to prepare for future sea level rise and threats from coastal wave surges.

This plan includes early warning systems and a vacation plan in case of flood events in the area. This would be supported by temporary accommodation (such as existing *Temporary Relocation Areas* in Khayelitsha) to provide shelter for affected residents.

- ***Drought prevention***

  Climate change is predicted to result to short rainy seasons and long dry summers in Cape Town. This will result to reduced quantity of water in dry seasons. In Khayelitsha, water pollution resulting from human land use (WWTP, dumping of litter into water areas) (Muchapondwa, 2010) adds to threats of future freshwater availability. Proposed expansion of city reserves in this dissertation will add to the protection of surface water resources as it would limit access to these areas preventing dumping and new settlements being formed in the Kuils river flood plain area. There is also water contamination as a result of spillage from the Zandvliet WWTP located on the south eastern part of Khayelitsha. This report proposes an increase in capacity by expanding the Zandvliet WWTP to accommodate current demands. Reducing soil erosion through

riparian buffers (planting and management of trees and grasses) along the river and wetlands would also reduce water pollution and maintain water quality.

Provide monitoring and maintenance of sewer lines in the area to prevent contamination of ground and surface water sources in an event of bust sewer pipes. This would also add to the preservation of water sources recognised as significant future regional water source.

Also inform and educate residents about water conservation by launching campaigns geared towards raising awareness about the state of water resources in Cape Town as well as the importance of water reserves in Khayelitsha for the Western Cape Province and the rest of the country.

c) Reducing Risks Associated with Temperature

- ***Fire prevention***

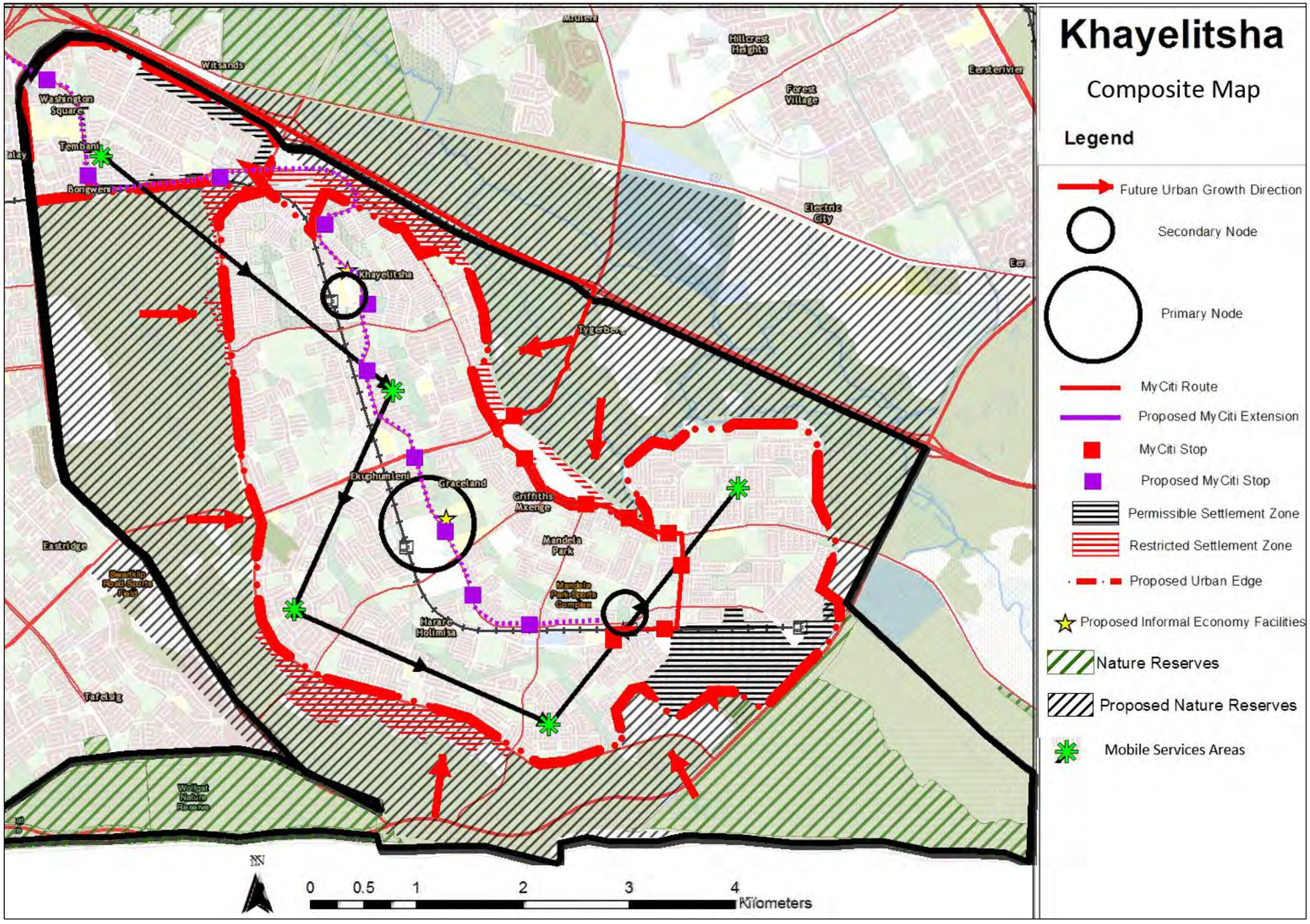
Informal upgrading interventions should consider including fire breaks through the design of settlements to contain fires in a small area and prevent the spread of fires across settlements in case of an outbreak. There should also be formal housing typologies provided for people designed to prevent the spread of fire with the aim of protecting local areas from fire hazards.

In addition, just as proposed for flood prevention, the fire prevention strategy should include early warning systems and a vacation plan in case of fire outbreaks in the area. This would be supported by temporary accommodation (such as existing *Temporary Relocation Areas* in Khayelitsha) to provide shelter for affected residents.

4.6 Composite Plan: Khayelitsha Local Area Adaptation Plan

Map 4.8 illustrates the composite local area adaptation plan for Khayelitsha. The map shows proposed development and planning strategies that are geared toward improving quality of life and increasing resilience to climate change. The map 4.8 shows spatial strategic interventions that seek to inform future growth of the area to achieve desired environmental, socio-economic and adaptation resilience outcomes. With the

implementation of these strategies, it is hoped that Khayelitsha will become a resilient place with equal opportunities and access to services for all residents.



Map 4.7: Local Area Adaptation Plan for Khayelitsha. (By Author. Source: CoCT GIS data 2013).

4.7 Conclusion

The local area adaptation plan in this chapter aims to increase levels of resilience to climate change for residents and infrastructure in Khayelitsha. Environmental protection, socio-economic development and risk management needs have been addressed. Through proposed strategies, living conditions and wellbeing of residents of Khayelitsha can be achieved, while preparing the area for future climate changes. The next chapter will outline the implementation of the local area plan that will seek to put proposed strategies into practice.

CHAPTER 5 IMPLEMENTATION

5 INTRODUCTION

For the proposed local area adaptation plan (in chapter 4) to achieve envisioned goals, it has to be appropriately implemented or applied in practice. Implementing the adaptation plan requires an alignment of goals with municipal, provincial and national goals and targets. Successful implementation also requires working together with interested parties as well as groups that will be affected by proposed plans. Implementing the plan also should adhere to existing regulations that guide development across the country as well as include supporting and monitoring aspects that will promote the success of implementing the plan. This chapter details steps and factors regarding the implementation of the proposed local area adaptation plan in Khayelitsha. The chapter begins with a timeline of different phases the adaptation plan will go through until all proposed actions are applied or implemented in Khayelitsha. A framework of proposed strategies and tasks to be completed in the implementation process is then outlined, showing respective departments and stakeholders that would be involved in supporting the application of proposals into practice in Khayelitsha.

Thirdly, guiding regulations that will be considered and adhered to by the proposed implementation process will be discussed. Lastly, this implementation chapter outlines supporting and monitoring factors and actions to be considered to ensure that application of the adaptation plan is successful. There is also a need to monitor and evaluate the progress of the implementation process at different phases to ensure that application of the proposed adaptation plan remains consistent with goals and objectives of the local area adaptation plan in chapter 4. The following section discusses the phasing process of the proposed adaptation plan implementation.

5.1 Phasing

Phasing is an important part of the implementation process as it helps prioritise actions that have to be applied in the initial stages (short-term) of the implementation process. These short-term actions create a foundation on which subsequent medium and long-term actions are built upon, and aim to intervene and address the most pressing issues. Implementation phasing guides the sequence of activities to be applied in Khayelitsha in an effort to intervene and create a climate resilient area. Figure 5.1 shows a Gantt Chart showing a timeline of events that will occur in different phases of the proposed implementation process.

Figure 5.1: Gantt Chart Showing phasing of the implementation. (By Author).

A point of departure in implementing proposed interventions in the adaptation plan in chapter 4 is implementing tasks that address the most pressing issues in the area such as natural resource protection, infrastructure, housing and economic development strategies. Because of human land use threats to natural areas that hold resources of great significance to Cape Town and South Africa, protection of natural areas will be prioritised. These natural areas identified form part of the region's biodiversity network (in the case of CBAs) and hold important resources needed for sustaining life in the area and the region as a whole (in the case of water resources). In addition to protection and management measures, suitable

development areas are identified for densification to increase the number of people per hectare in areas identified as future nodes, thus accommodating more people in light of limited vacant land suitable for development.

Once environmental interventions are under way, social economic development tasks would then commence, building up from and considering impacts on natural resources. The social state of the area (according to trends highlighted in chapter 3) requires interventions aimed at improving people's standards of living. Social facilities should be clustered in densely populated nodes proposed along activity routes. Strategies for developing the local economy would be implemented in parallel with social development tasks. This is to ensure that local residents have access to economic opportunities and reduce travelling distances to places of work.

The phasing Gantt chart in figure 5.1 also shows a timeline for the application of risk management actions. These aim to reduce vulnerability to climate change in Khayelitsha. In terms of proposed implementation phases, consultation with local residents would be done through public participation in all phases of rolling out tasks. Different stakeholders must also be consulted during the course of implementation, including consultation with professionals from different disciplines and fields of expertise to review the adaptation plan as it is applied in different phases. The following section will show different stakeholder and other role players that would be involved in the implementation of the proposed local area adaptation plan.

5.2 Strategies and Tasks plus Stakeholders involved

Proposed Strategies	Proposed Actions	Responsible Departments	Supporting/Other Departments
Protect and Manage Natural Resources	Extension of nature reserves and the wetlands park	CPD (CoCT)	ERMD (CoCT), DEA&DP (PGWC)
	Wetlands and River cleaning	DWAF (NG), DEA&DP (PGWC)	PGWC,
	River bank management	DWAF (NG)	
	Enforcement of protection regulations	LE (CoCT)	CPD (CoCT)
	Removal of invasive plant species	DEA&DP (PGWC)	CPD (CoCT)
	Local Natural Resource Management Department	DEA&DP (PGWC)	CPD (CoCT)
Promote Socio-Economic Development	Provide infrastructure and utilities	USD(CoCT)	P&BDM (CoCT), DTPW (PGWC)
	Establishment of mobile services	USD (CoCT)	DSD (PGWC)
	Clustering of social services	P&BDM (CoCT)	SPUD, CPD and S&RD (CoCT)
	Increase community support services	USD (CoCT)	DSD (PGWC)
	Housing provision plan	HSD, SPUD (CoCT)	DHS (PGWC)
	Support the informal economy	EDD (CoCT)	DEDT (PGWC)
	Establish the green economic sector	EDD (CoCT)	DEA&DP (PGWC)
	Improve transport system	TR&S (CoCT)	
	Other infrastructures to support economic development	USD (CoCT)	EDD (CoCT), DEDT (PGWC)
Protect People and Assets in Vulnerable Areas	Redefine the Urban Edge	SPUD (CoCT)	
	Relocate People in Vulnerable Areas	HSD (CoCT)	DHS (PGWC)
	Flood prevention	DRMC, TR&S (CoCT)	
	Drought prevention	DWAF (NG)	DRMC (CoCT)
	Fire prevention	DRMC (CoCT)	

List of Acronyms

CoCT – City of Cape Town Municipality
PGWC – Provincial Government Western Cape
NG – National Government

CPD – City Parks Department
DEA&DP – Department of Environment and Development Planning
DEDT – Department of Economic Development and Tourism
DHS – Department of Human Settlements
DRMC – Disaster Risk Management Centre
DSD – Department of Social Development
DTPW – Department of Transport and Public Works
DWAF – Department of Water Affair
EDD – Economic Development Department
ERMD – Environmental Resource Management Department
HSD – Human Settlements Directorate
LE – Law Enforcement
P&BDM – Planning and Building Development Management
SPUD – Spatial Planning and Urban Design Department
TR&S – Transport, Roads and Stormwater
USD – Utility Services Directorate

5.3 Guiding Regulations

In planning, regulations help guide planning processes help guide planning processes and land use decisions to ensure that development actions are considerate of natural assets and that they work towards improving living standards of people. Thus planning regulations are important for safeguarding natural assets and promoting better living standards and wellbeing of residents. In South Africa, local governments are tasked with municipal planning responsibilities, where municipal planning is listed (under Part B of Schedule 4 of the constitution) as a local government responsibility (CoCT, 2013). However, when making planning decisions local authorities have to adhere to regulations that ensure that planning processes will benefit the majority of the population today and in the future.

Below is a discussion of some major legislation that would have to be considered when implementing the proposed local area adaptation plan, and all development and adaptation intentions proposed in this dissertation seek to align with objectives of these legislations.

National Environmental Management Act

The protection and management of natural resources strategy is aligned with the NEMA guidelines. NEMA acknowledges the fact that the majority of South Africans live in harmful environments that threaten their wellbeing whereas everyone has a right to an environment that doesn't threaten their health and wellbeing. NEMA would also inform the formation of proposed environmental management interventions.

Land Use Management System

The LUMS present the Cape Town zoning scheme (CTZS) that outlines provisions that guide future development in Cape Town, with the aim of ensuring proper use of land and guiding future development decisions to be aligned with the CoCT development objectives. The CTZS will inform and guide proposed interventions in the adaptation plan in chapter 4.

Spatial Planning and Land Use Management Act

The SPLUMA legislation acknowledges fragmentation of planning processes at different scales of settlements created by past unjust legislation (RSA, 2013). Therefore, SPLUMA provides a framework for integrating spatial planning and land use management to address past ills in the planning systems and promote collaboration in planning processes and among planning bodies.

National Water Act

Water management interventions proposed in the adaptation plan will seek to achieve rehabilitation of water systems to increase the quality of water resources in the area. This would be aligned with the NWA that seeks to manage national water resources to ensure that the use of water is sustainable and does not compromise future water availability.

***Social Housing Act* 16 of 2008**

The delivery of housing is a major challenge in Khayelitsha where a significant number of people have no access to formal housing with services such as water and sanitation. This is manifested by informal settlements that have persisted in the outskirts of the area. These informal settlements are not managed or guided by and planning regulation resulting to location in areas that are not suited for development, which has resulted to increased vulnerabilities of residents in those informal settlements. The provision of housing proposed in the local area adaptation plan would be guided by provisions in the Social Housing Act.

From these legislations, a common theme that arises is the effective and sustainable use of land to enhance human well-being while ensuring minimum harm to the natural environment which is also related to sustainable development objectives. The following section will outline a discussion of various processes to be considered to ensure the success of the implementation process.

5.4 Factors that Enable Successful Implementation

Implementation requires different activities to take place in order to ensure success of the process. This section discusses different factors that influence the success of implementing development proposals and strategies.

5.4.1 Implementation Support and Monitoring

a) Public Participation

The aim of the public participation process is to promote the involvement of residents of Khayelitsha in making decisions that influence the proposed adaptation plan. Consultation with local residents will allow for a collection of issues on the ground from the people who are affected on a day to day basis. This allows for the adaptation plan to be based on the needs of the local residents who are at risk of changing climate conditions. Within the public participation process, stakeholder participation will also be included where various stakeholders are identified and consulted to assist with rolling out the implementation process. These stakeholders will also include professionals from different fields that will be consulted to give their expert guidance to add value to the application of proposed strategies. Public participation process will also be included in stages between different phases and times throughout the implementation process. This will enable updates to be made in the implementation of development proposals to enhance and improve the process to achieve desired outcomes.

b) Cross Departmental Coordination

Spatial planning should serve as a tool for collaboration where implementation of development ideas involves a diverse range of actors to meet diverse expectations of society (Haughton et.al. 2009). Collaborative planning is promoted in an attempt to combine different interventions and different plans, and pool together ideas that will inspire innovation in future planning and also bring about solutions to major issues in the study area. This will involve consulting with different institutions such as government departments, non-governmental organisations, the private sector institutions as well as local community cooperatives and organisations, local forums, politicians and religious groups. To this end, coordination of ideas and plans will be invited to create unified (and considering all aspects and the majority of interested

parties) adaptation solution for the area. However, coordination is hindered by lack of cooperation of some stakeholders especially with information sharing. This requires for transparency in the coordination process to establish trust and a common goal for all parties.

c) Resources

For implementation attempts to be successful, they should be supported by adequate resources, given the high financial costs of development coupled with limited financial resources for the City of Cape Town municipal area. Therefore, sources of funds should be identified and available funds be used cautiously to ensure that proposed development plans are implemented successfully. Here, the phasing of the implementation process becomes important in ensuring that financial resources are appropriately allocated to different proposals and tasks. The primary source of funds would be the City of Cape Town municipality sourcing a portion of public finance. In addition, national departments would also provide funding for developments that are aligned with their objectives, for instance department of human settlements would fund proposed housing developments and the department of education would fund the development of educational facilities. The Western Cape government, with its various departments would be involved in funding implementation of various projects in the area. Other sources could be from national agencies and funds such as the National Urban Reconstruction and Housing Agency providing funding for affordable housing, community facilities and infrastructure and the Green fund which would be the main source of funds for implementing adaptation and green economy proposals. In terms of investments, private sector actors would invest in some areas of proposed development such as retail or housing which would add to implementing the overall adaptation plan.

d) Monitoring and Assessment of Projects

In every implementation process, there is need to monitor and evaluate projects and interventions to enhance the contribution to the area interventions are intended for. This allows for assessing implementation progress and ongoing activities to inform and enhance future activities. The goal is to learn about what initiatives in the implementation process are working and ones that are not meeting intended goals,

then work on improving lagging initiatives. Without the monitoring and assessment process, it would be difficult to judge if interventions are meeting intended targets and if the implementation process is going the right direction toward meeting envisioned goals (UNDP, 2009). Monitoring also takes into account future spatial changes and trends as settlements grow and allows for interventions to be updated in order to adapt to the changing spatial context of area.

This implementation process would go through a series of checks and assessments done in different phases. To this end, it is suggested that reviews conducted over 5 year intervals are carried out during the rollout of the proposed adaptation plan. This would be accomplished by research processes producing progress reports that collect information concerning the success of the application of plans on the ground. This will also inform decision makers in the implementation process about whether there needs to be alterations made to enhance processes of the entire adaptation plan. Key performance indicators (KPIs) will be used as criteria for evaluating the effectiveness of the proposed local area adaptation plan. KPIs are a set of measures that can be quantified and used to compare performance of interventions with their intended goals (Parmenter, 2007). These will be devised based on the strategies proposed in the local area plan in chapter 4 of this report. Thus, key indicators that would be used would consist of protection of environmental areas, access to social facilities and services, access to economic opportunities, and the level of resilience from weather related risks. If there has been no improvement towards intended results in Khayelitsha, obstacles would have to be identified and resolve.

5.5 Conclusion

This chapter has discussed the implementation of the proposed climate change adaptation plan in Khayelitsha. It seeks to show different factors necessary for proosed interventions to be successfully implemented. The next chapter is the conclusion of this dissertation and will provide a summary of this report.

CHAPTER 6 CONCLUSION

Various scientific studies show that climate change is happening and the intensity of climate events are likely to increase in the future. This chapter serves to complete the local area adaptation plan for Khayelitsha. A local area adaptation plan for Khayelitsha was proposed based on the context of the study area. A case study was used to gain an understanding of the underlying issues influencing vulnerability to climate change in Khayelitsha. To this end, strategic interventions seeking to reduce the impacts of climate change to local residents were proposed. The dissertation used a spatial planning tool (local area plan) to address current and predicted climate related risks in the study area. An implementation plan was then framed, showing the steps and timeframes that would be taken to successfully implement proposed interventions.

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